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The Failure and Repair of the Winston (N. C.) Water Works Dam

By J. N. Ambler*

During the night of Mar. 14 and the morning of Mar. 15 this section of North Carolina was visited by a rain storm, so prolonged and violent, that it is credited by the oldest inhabitants as having produced the greatest flood in the local streams within their recollection. The ground had become thoroughly saturated by frequent rains during the week previous, so that with the heavy and continuous downpour which lasted through the greater part of the night, Mar. 14, every condition existed for a heavy "run-off" from the streams by daybreak following.

Fig. 1. View of Spillway Portion of Winston Dam, Before Failure of Earth Embankment

Fig. 2. Break in Winston Dam, Looking Upstream; Showing Cracked and Twisted Wing Wall

At 9 a.m., Mar. 15, the streams were brim full, with a heavy rain still falling. The rain continued with but little abatement, checking somewhat for only a few minutes at a time, until noon. During the morning hours there were a number of showers of the heaviest character.

As a result, all the neighboring water courses rose rapidly between 9 and 12 o'clock, during which time bridges and dams were washed away, embankments settled, railroads had to cease operation and bottom lands were scoured out to an extent unknown here before. The total precipitation on Mar. 15, as given by the weather observer at Salem College, was 6 in., most of which fell during the forenoon.

By far the most notable failure which occurred was that of the dam impounding water for the city of Winston. This structure suffered a breach 70 ft. long and 24 ft. deep, causing the release of the entire amount of impounded water, some 175,000,000 gal., into the valley below.

The dam was a combination masonry and earth structure, built in 1904, having been constructed by contract, under the supervision of the city engineer. It consisted of a massive rubble spillway (Fig. 1) with wing walls, near the center, the ends being earth embankments. The embankment at the southern end was provided with a rubble core about 3 ft. thick, while the northern embankment was supported by a rubble retaining wall. The spillway was provided with a large sluice gate near the bottom, the discharge being on a solid rock floor. The main structure of the spillway was founded on solid rock, and so was the core wall, for about half its length.

This rock is a mica schist, somewhat softened by weathering, and slopes down from the southern end (which failed) toward the spillway. Immediately at the spillway is an open space, now filled with water, over which no critical examination of the bottom has been possible as yet. The masonry of the spillway and lower wing walls is all of massive rubble work, well pointed, and giving a smooth and substantial appearance. The core wall, however, is laid of large and small stones, loosely put together, and not thoroughly bonded, and not having its voids well filled with mortar. No pointing was done on this wall, and altogether it must be regarded as far from a strong and substantial curtain for the center of the embankment. Besides, nearly half of the core rests on an earth foundation, some parts of which are very soft.

Fig. 3. Looking Downstream Through Break in Winston Dam; Pumping Station in Distance

The earth used in the fill was taken from a borrow pit close by, and being the result of the disintegrated mica schist, is full of scales of white and black mica,

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and is of such character as to lend itself very readily to become a sort of quicksand when thoroughly saturated. A more unsuitable type of earth for a dam would be hard to find, though it is the only kind available. So treacherous is this material that the embankment around the settling basin at the pumping station became so saturated with water that a man would mire up to his knees when walking on it, near the toe of the bank, which was about 10 ft. high.

There had been similar indications of seepage through the embankment of the main dam ever since its completion. At the time of the failure, the toe of the embankment had become very soft and miry. This condition would now seem to be attributable to a considerable spring which rises through the fissures of the rock immediately under the core wall, and which was not safeguarded. This might have become a serious source of danger in time, but played no material part in the failure, as recorded.

The drainage area from which water was collected is 7½ square miles. On the morning of Mar. 15 the pond was full, with some 18 in. of water on the crest of the spillway. The sluice gate was shut, but had it been open it could not have prevented the failure. It was opened later.

At about 11 o'clock, following a terrific shower, the superintendent at the pumping station noticed that the water was rapidly approaching the level of the embankment crest. While telephoning to notify the water office in the city of the peril of the dam, the water rose so rapidly that when he looked next a sheet 12 in. deep was running over the entire crest of the dam, rather over 300 ft. in length. At the northern end, the water having to pour over the retaining wall, no harm was done. The bank being sodded at the southern end, resisted for some fifteen minutes, after which rapid sloughing began. Had the core wall been substantially constructed, it would doubtless have stood intact until the earth on the lower side was for the most part removed, when it would have failed by rotation.

If this had been the case, however, it must undoubtedly have resulted in the complete destruction of the large pumping station, filters, alum pool and clear water basin in the valley below. As a matter of fact, as the earth sloughed away on the lower side, the core wall crumbled away, a stone at a time, keeping pace with the destruction of the embankment. Thus it took from 11 a.m. until about 12:30 p.m. for the core to break up as low as the crest of the spillway, and it was something like 4 p.m. when the core wall, for a length of 70 ft., had broken away down to the bed rock of the foundation (see Fig. 4).

In this manner the immense reserve of water which the city was carrying was let out gradually, and the destructive effects below were reduced. The rush of the current broke off the lower wing wall on the side next to the breach, and twisted it about 2 ft. out of line. Portions of the remaining core in the vicinity of the breach are cracked, and will have to be taken down; otherwise the remainder of the dam is intact.

The effects of the flood below comprised the tearing up of much valuable bridges, and damage to trestles on the Winston-Salem Southbound Ry., and Southern Ry., and the flooding of a number of buildings in the town of Salem. There was no material damage done at the pumping station, and no loss of life has been reported.

With the reservoir empty, the city had no more water than was contained in the settling basin, the clear-water basin, and the standpipe, in all not more than 4,000,000 gal. It became necessary for the water committee to have all the factories shut down, and to call on all citizens to use as little water as possible while some arrangements could be made for handling the situation. A gasoline engine and centrifugal pump were in-

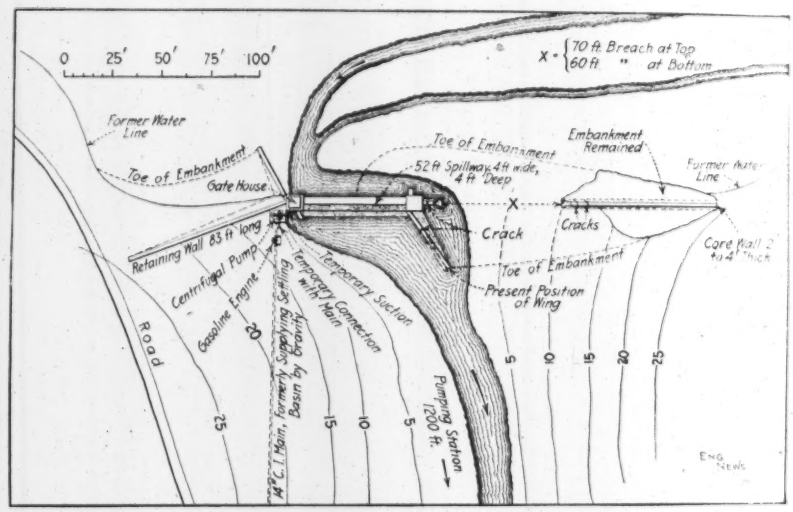


FIG. 4. SKETCH PLAN OF THE WATER WORKS DAM, WINSTON, N. C., AFTER ITS FAILURE

stalled for raising the water passing through the reservoir site up to and forcing it through the 1200 ft. of 14-in. main between the dam and the alum pool.

EMERGENCY SUPPLY

At the request of the mayor, the writer was placed in charge of the situation, and undertook the work of restoration, turning his attention first to installing the temporary pumping plant so that it might be depended upon to hold out for some time, and afterward to the outlining of a plan of restoration; also organizing and equipping the necessary force to put the plan into effect, assembling material, machinery, etc.

The best machinery that could be got in the emergency was a 6-in. centrifugal pump, run by a 12-hp. gasoline engine. The pump was mounted above the water from flood, with a suction lift of rather over 12 ft. The engine running at its highest possible speed under this load was making 280 r.p.m., its nominal rating being 550. At this speed, without stoppages, it would deliver approximately 1,225,000 gal. in 24 hours, pro-rating by speeds. It was found that the engine was working up to its utmost capacity, though the actual drive lift was only about 6 ft., and allowing 2 ft. for friction, the total head to be worked against was 20 ft. As it became necessary to work it continuously day and night, great trouble was experienced from over-heating of the cylinder, and also of the pump, it being in two parts. This was remedied by running a ½-in. pipe from the drive pipe through the cooler, and allowing fresh water to pour around the jacket continuously.

REPAIRING THE DAM

At first it appeared best to build a coffer-dam to keep the water back from the foundation work, and at the same time raise the water high enough to enter the 14-in. main and flow by gravity to the alum pool. This would have required a coffer-dam some 12 ft. high and 165 ft. long, and as it would have had to carry any flood that came, a very secure form of construction would have been necessary. This was afterward abandoned, because of its cost and the delay to the main work which would have been caused by its construction. By keeping the sluice gate open, all water under normal conditions could be passed through, and the small amount now running through could be dammed off by an insignificant coffer-dam.

In this method, dependence is being put in collecting all material and equipment.

and rushing the core in. Arrangements will be made for passing small floods should such occur, by leaving a 4x4-ft. opening in the core next to the spillway. At this point the core will be bonded into the masonry of the spillway. The lower side will be partly supported by an earth embankment as the core rises. It was believed that the core should be rebuilt of concrete instead of rubble masonry.

Since stone masons are now very hard to get in this community, and charge union rates for their services, the element of speed, which is intimately connected with economy and safety in this case, pointed to concrete. The forms would be simple and cheap and could be raised with the wall, and with a good concrete mixer, sufficient force and material on hand, the concrete wall can be built much more quickly than one of rubble, and can be more easily made water tight. By this method, the work can be done in less time than by laying rubble work equally as good, thus reducing the excessive rental of pumping machinery which the city is now bearing, and enabling the work to be completed before the long rainy spell in May, with its attendant dangers.

The work at present consists of preparing the foundations for the core, blasting out a shallow trench in the rock for that purpose, organizing the force, repairing roads and bridges, purchasing material, opening a quarry, installing a steam percussion drill, rock crusher, blacksmith shop, shanties, eating house for laborers, cement house, etc. The lower wing wall, which is broken off from the main body of masonry and is deflected inwards, offers an interesting problem. It can be left for solution for the last, when a coffer will be thrown around it and the nature of its foundation examined. Most likely an effort will be made to undermine it with hydraulic jacks and force it back to position, after which a suitable concrete foundation may be prepared. If this fails, it may become necessary to shoot it up and rebuild it in concrete, facing the forms with stone so as to present a similar appearance to the rest of the structure.

Since the failure of the dam was due to insufficient spillway, this will be increased in length from 52 ft., at present, to 100 ft. A buttress will be built on the lower side of the spillway, where the old and new work join.

The stream now flowing through the sluice gate in the dam is cutting a deep channel through the mud deposits forming the bottom of the now empty reservoir. When this water reaches the centrifugal pump it is about as roily and full of mud in suspension as it can be. Trouble was anticipated from this source, as it was feared that the filters could not remove so much mud and give an effluent approximating in purity and clearness the water for which the city is famed.

The filters are of the Warren mechanical type, round cypress tubs with rotary agitators. By frequent washings, and increasing the alum from 1½ to 2¼ grains per gal. a very satisfactory effluent has resulted.

The city is now preparing to purchase and install machinery of its own for the pumping, so selecting it as to be of use for general construction purposes after finishing this work.

A Typical Design for Division Engine Terminals*

In locating an engine terminal, the facilities should be placed with reference to the yards and main line in the most advantageous position possible; that is, so that the distance between the engine terminal and the points where engines begin and end their service shall be a minimum, and so that reverse or conflicting movements shall be avoided as much as practicable. The idea to be kept in mind is the most direct and convenient (that is, rapid and economical) performance of those things required for an engine in its terminal in that sequence which answers all requirements in the order of their urgency.

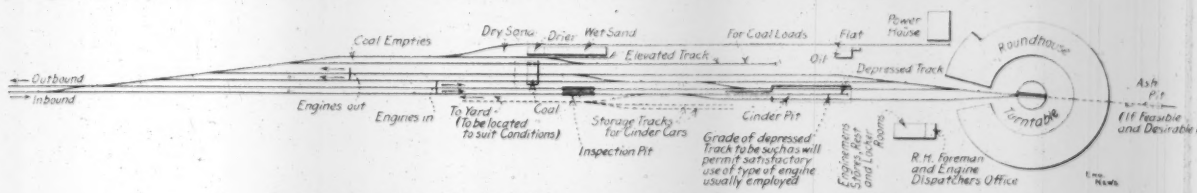
On the arrival of a locomotive at its terminal, the first imperative demand is likely to be for water, and this demand is likely to be the last when leaving the terminal for service.

After an incoming engine has been protected by receiving water, the next step appears logically to clean its fire or remove it entirely, according to need. And then place the engine as quickly as possible in the engine house, where necessary repairs may be made, engine cleaned, etc. The cinder pit should be located as close as practicable to the engine house, and yet permit of engines moving off cinder pit in normal direction, being switched direct to an outbound track without using or fouling the turntable, as may often be desired.

Coaling should be reserved, if practicable, until just before the engine reenters service, in order that it may do so with a maximum supply of fuel; and also because the cleaning or removal of fire on cinder pit, as well as repairs of engine tank or other repairs, can be accomplished without that interference that might result from having the tender filled with coal. For this reason the location of the coaling station should be primarily to serve the outbound tracks. However, as incoming engines often require coal, the coaling station should be located, so that coal may be taken also by an engine on an inbound track.

The trestle type of coal dock may be used if desired, if only two coaling tracks are required. This can be located between the inbound and outbound tracks in same relative position as shown on the typical plan.

The most convenient and economical arrangement for storing and drying sand is at the coal station, where it may be handled by the same attendants. Sand should ordinarily be delivered to engines passing on the inbound tracks.



TYPICAL PLAN FOR ENGINE FACILITIES AT A RAILWAY DIVISION TERMINAL

The arrangement of facilities should permit of large increase in capacity of cinder pit, coaling station, etc. In this connection, the idea of having the coaling station at a busy terminal comprising two independent units makes a strong appeal for approval, in view of the possibility of one of the hoisting plants suffering temporary disability from breakdowns, or other cause.

The location of storehouse, oil house, enginemen's tool and locker rooms need not be prescribed arbitrarity, but should be as close as practicable to the engine house and the cinder pit. However, where any of these buildings are served by their own tracks, those tracks should be so located and connected as not to interfere with the uninterrupted free use of the engine tracks.

A system of ample lighting facilities is important, with lights distributed so as to avoid, as far as practicable, darkness or shadow where men are engaged in work upon engines.

In any case of actual construction, physical limitations as to space and shape of the site will impose more or less modification of the plan recommended, but it will come generally within the possibility of any given set of conditions.

*Abstract of the report of the Committee on Yards and Terminals, presented (and adopted) at the annual meeting of the American Railway Engineering Association, held at Chicago, Mar. 19-21, 1912.

Improving Upper Mississippi River

By E. F. Linderman*

A navigable channel for the Upper Mississippi River, with 6 ft. of water at low-water, all the way from St. Paul to St. Louis, is a project upon which the government engineers have been working for some years. The method of securing the desired depth consists largely in regulating the width of the natural channel and confining the flow to one main channel. In this article an engineer engaged upon the project describes the character of the works and the methods of executing them, and gives some particulars as to the unit cost.

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The project for the improvement of the upper Mississippi River, which is being carried out by the U. S. Government, proposes the contraction of the channel or waterway by means of wing and closing dams to such an extent as to afford (by means of the scour thus caused) a channel with a minimum depth of 6 ft. at low-water.† The river and harbor act of June 25, 1910, provided that this improvement would be prosecuted with a view to its completion within a period of 12 years. The work is performed partly by hired labor and use of government plant, and partly by contract. The distance from St. Paul to the Missouri River is divided into seven divisions. This paper relates to work on the Dubuque division, which extends from the mouth of the Wisconsin River to LeClaire, 136 miles.

The course of the Upper Mississippi forms a succession of great bends, and the current rebounds from bank to bank at various angles. The method of improvement resolves itself into the matter of narrowing the channel, which requires three classes of work: (1) the construction of wing dams which extend from the shore to the channel line, (2) the construction of closing dams to shut off side chutes or secondary channels and thus force the water into the main channel, (3) the protection of the shores against cutting at points where they form the boundary of the channel. The arrangement of these classes of work as provided on a certain stretch of the river is shown in Fig. 1.

Channel limits are fixed, where possible, to allow the current to follow its natural course, and with a view to holding stationary as great a portion as possible of the large sand bars. (See Fig. 1). The proposed width of channel increases from 300 ft. at St. Paul to 1400 ft. from the Illinois River to the mouth of the Missouri River. At the Rock Island Rapids, however, it is reduced to 200 or 250 ft., the widths above and below the rapids being 900 ft. and 1000 ft., respectively.

Wing dams are inclined upstream, and in locating these dams, the usual practice is to give angles (with the direction of the current) and spacing as follows: in straight reaches, inclined 105 to 110° with the current and spaced a distance equal to $^5/_7$ of the channel width; in concave reaches, angle 100 to 102½°, and a spacing of half the channel width; in convex reaches, angle 90 to 100° and a spacing equal to the channel width.

The wing dams, closing dams and shore revetments are of brush mattresses loaded with rock. The approximate proportions are 1 cu.yd. of rock to 2 cu.yd. of brush in the wing dams, 1 to 1½ in the closing dams, and 1 to 1 in the shore protection.

†A description of this entire project, with particulars of the character of the work required was given in a paper on "The Improvement of the Upper Mississippi River," by Col. C. McD. Townsend, U. S. Corps of Engineers, published in Engineering News, May 6, 1909.—Editor.

Construction Plant and Force

The following is the plant required to handle approximately 150,000 cu.yd. per season.

1	Towboat	1-7×25×4
1	Steam launch	1-6×42×3
1	Building boat	1-6×42×3
1	Mat boat	1-6×28×4
2	Quarterboats	2-8×30×3
1	Officeboat	8×20×3
1	Comb. storeboat and carpenter shop	8×16×3
10	Rock barges	8-8×30×3
8	Brush barges	11-8×28×3
2	Coal barges	8-8×28×4½
		1-8×20×4½

The towboat is a stern-wheel river steamer, with engines having cylinders 12x72 in. It has cabin capacity to accommodate 17 men (double crew), 24-hour basis, and is used in towing material to the work. The steam launch is a smaller stern-wheel boat (cylinders 6x42 in.), and is used in switching barges at the works, securing supplies, etc. The building boat (Fig. 2) is equipped with a steam boiler to furnish power with which to operate several capstans, and a 100-ft. tilting way on which the mattresses for the dams are built. The mat-boat has stationary ways inclined at an angle of about 30° on which the mattresses for shore protection work are constructed. The quarterboats have a two-story superstructure and accommodate about 50 men. The rock barges carry about 150 cu.yd.; brush barges, 600 cu.yd.; coal barges, 150 tons of coal.

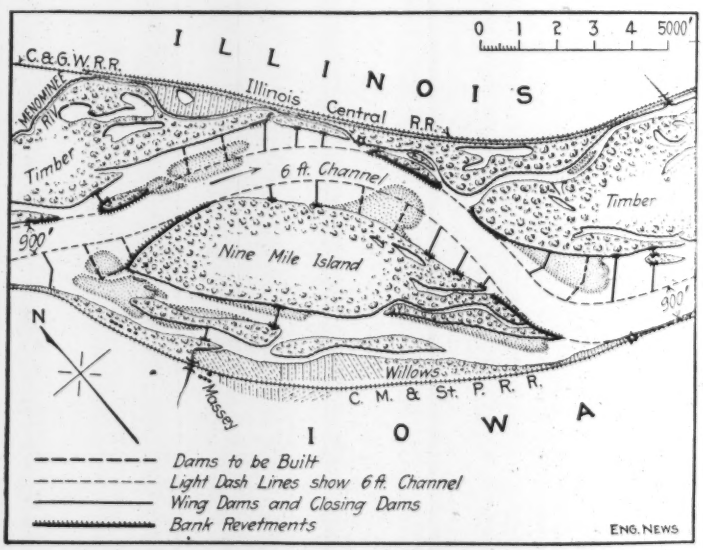


FIG. 1. PLAN OF A PORTION OF THE UPPER MISSISSIPPI RIVER, SHOWING THE IMPROVEMENT WORKS FOR A 6-FT. CHANNEL

(The works include wing dams, closing dams and shore revetment.)

The force required for the above equipment and the amount of work stated is given in Table I. The wages are per month, except that day wages are given for laborers. As to the commissary service, the cost per ration averages (17,420 rations) 35.15c. raw or 47.53c.

cooked and served. The fuel for towing averages $23.15 per day or 42.3c. per mile for the towboat (24 hours per day) and $2.96 per day or 14c. per mile for the steam launch (12 hours per day).

TABLE I. FORCE AND WAGES

Towboat:	
1 Master and pilot	$125
1 Pilot	100
2 Enginemen	75-90
1 Clerk	50
1 Mate	60
1 Watchman	40
2 Firemen (each)	45
6 Deckhands (each)	35
1 Cook	60
1 Waiter	25
Steam Launch:	
1 Pilot	75
1 Engineman	60
1 Fireman	40
1 Deckhand	35
1 Cook	45
Dam Building Force:	
1 Foreman	100
1 Clerk	50
1 Engineman	50
1 Watchman	40
2 Boatmen (each)	40
Laborers (20 to 40)	1.25
1 Cook	60
Waiters (1 to 3)	30
Shore Protection Force:	
1 Foreman	100
1 Clerk	50
1 Watchman	40
2 Boatmen (each)	40
Laborers (20 to 40)	1.25
1 Cook	60
Waiters (1 to 3)	30

Building a Wing Dam

Range poles are first placed denoting the line of the dam. Then the bank on which the dam is "tied" is revetted for 50 to 125 ft. above and 100 to 200 ft. below this line (depending on local conditions), so as to prevent the water cutting around the shore end of the dam.

Disk anchors are planted on a range 200 ft. above the line of the dam, being spaced 100 to 300 ft. apart, according to the strength of the current. On these, boats are fleeted back and forth as the work progresses. Disk anchors with their anchor cables attached are buried in the bed of the river and are used in mooring dam building and hydraulic dredging outfits. These anchors are of cast iron and are of the inverted mushroom shape, Fig. 3. They are 20 in. diameter and weigh 50 lb. The metal tapers in thickness from 1½ in. at the center to ¼ in. at the edge. A 2-in. center hole provides for the insertion of the jet pipe, and two 1-in. holes for the wire cable, as shown. A 60-ft. section of ¾-in. cable is looped and fastened at the anchor with clips; the opposite end is provided with a 6-in. iron ring in which manila ropes are fastened.

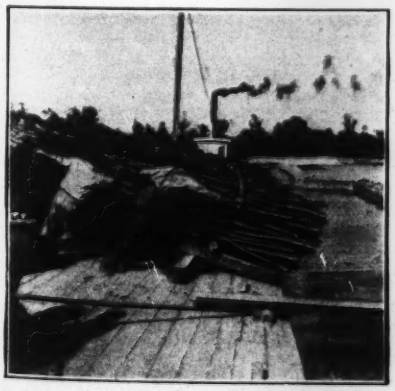


Fig. 4. Launching a Brush Mattress from the Building Boat or Barge

Fig. 2. Boat for Building Brush Mattresses

(The cross timbers on the deck are the ways on which the mattress is built; they can be raised to an inclined position to launch the mattress.)

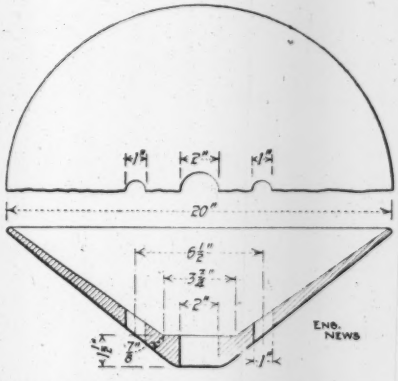


Fig. 3. Disk Anchor for Mooring Boats in River-Improvement Work

The only apparatus necessary in planting these anchors consists of a 30-ft. pipe connected by rubber hose to the deck pump (with which steamboats and building-boat are equipped). This pipe is fitted with a short nozzle to be inserted in the center hole of the anchor. The weight of the pipe holds the nozzle in position while lowering the anchor by the cable to the bed of the river and follows with its position unchanged as the action of the water jet buries the anchor in the sand. The pipe is raised as soon as the pump is stopped, leaving the anchor embedded. A buoy attached to the free end of the cable indicates the location of the anchor.

Ordinarily in sand the scouring effect of the jet of water is sufficient to allow the anchor to be buried 12 to 15 ft. in 10 minutes from the time of starting the pump. The anchor is easily raised by the use of the jet. The holding power of an anchor, embedded in 12 to 15 ft. of solid sand, on a horizontal pull, is greater than the breaking strain of a high-grade ¾-in. wire cable.

The building-boat is placed in position broadside to the current and moored with 1½-in. manila ropes to two or more disk anchors, and a line from the end of the boat to the shore serves to control cross-current motion. A barge loaded with brush is placed immediately above the building-boat, and a barge loaded with rock is placed on the lower side. This is fastened to the building-boat with manila ropes, leaving an open space of about 20 ft. between them, the upper side of the rock barge being on the line of the dam.

Two sets of binding poles (or three sets in deep water) are placed longitudinally on the 100-ft. way on the building-boat and bundles of brush are laid crosswise on these poles, with tips upstream. Poles placed on top of the brush are fastened to those underneath with four to eight No. 16 annealed wires between each group of two to four bundles, depending upon the thickness of the mattress and the depth and velocity of the water. Then ¾-in. manila mat-lines are placed around the "upstream" binding poles, the lines being 8 to 15 ft. apart, according to local conditions.

The mat being completed, the engine is started and elevates the upper side of the ways so as to cause the mat to slide off into the water, as shown in Fig. 4, the ways having been previously greased. The floating mat is easily placed in position. One end of each mat-line is made fast to a kevel on the building-boat; the other end is hauled taut (so that the bight is tightened around the binding poles of the mat), and is then made fast to a kevel. During these operations the mat is apt to become more

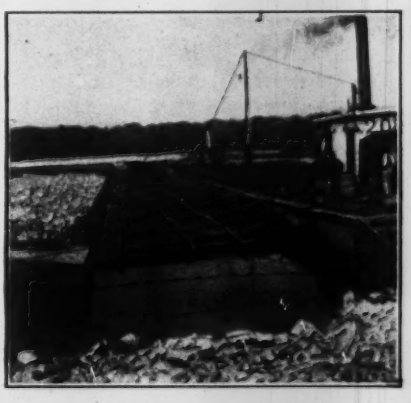


Fig. 5. Brush Mattress Floating between the Building Boat and Rock Barge, and Ready to be Sunk by Loading It with Rock

or less out of line, which is corrected by either winding up or slacking the holding lines by steam capstans on the building-boat.

When the mat is properly adjusted, the rock barge is hauled close to it, as shown in Fig. 5. In shallow water, rock is loaded till the mattress is forced to the bottom. In swift water from 10 to 20 ft. deep or more, the operation is more difficult. Rock is first loaded on the upstream portion of the mat, forcing it down at an angle of 15 to 20° to the horizontal, thus allowing the current to run over it and assist in forcing the mattress down. Trained men slack the mat-lines, as directed by the foreman, while the mat is being loaded. Considerable skill and experience are required to properly load and sink a mat in the desired position, the tendency of the mat being to "turn turtle" and dump its load of rock.

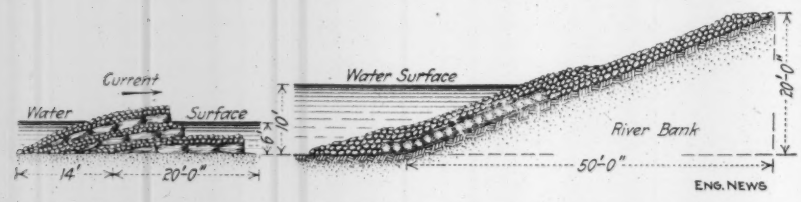


FIG. 6. CROSS-SECTION OF WING DAM

FIG. 7. CROSS-SECTION OF BANK REVETMENT OF BRUSH AND ROCK

FIG. 8. A COMPLETED WING DAM IN THE MISSISSIPPI RIVER

The mattress being sunk, the mat-lines are removed, and the outfit is fleeted out (or in) 100 ft., and the operation repeated. This is continued for the full length of dam.

Fig. 6 shows a section of a wing dam. The first or lower mattress called the "apron," is but one bundle thick and extends about 10 ft. below the dam proper, to prevent scour from water flowing over the dam. The second and following mattresses are usually two or three bundles thick, each succeeding course being held upstream sufficiently to make the downstream slope of the dam 1 on 1. The upstream slope is 1 on 2, which in some cases necessitates a "header" mattress being placed. The wing dams are built to a height of 4 ft. above the low-water level in 1864. Fig. 8 is a view of a completed wing dam. In some cases the wing dams are constructed on ridges of sand formed by pumping material from the channel by means of hydraulic dredges.

The closing dams, which are built entirely across side chutes to shut off the flow, are built in practically the same manner as wing dams, but are made wider and stronger (using a greater proportion of rock to brush) in order to withstand the greater pressure. Some of these dams carry a head of 2 ft. or more during low water. The closing dams are built to a height of 2 ft. above low water. This height causes a draft of water which increases the tendency to deposit sediment in the chute.

SHORE REVETMENT WORK

The banks to be protected are first cleared of all trees, and stumps are grubbed out. The bank is then graded down to the water surface to a slope of 1 on 1½ to 1 on 3. The slope depends on the height of bank and nature of soil, low banks of light loose soil requiring a greater slope than high banks of compact firm soil.

The mats for revetment are built in a somewhat different manner from those for a dam. Poles, spaced 5 to 8 ft. apart, are placed crosswise on longitudinal ways which extend beyond the end of the mat-boat nearly to the water surface to prevent rupture of the mat in launching. The ways are fitted with iron caps and kept well greased. The bundles of brush are placed on the poles in single layers parallel to river bank (with tips upstream), each course overlapping the former by 30 to 50% of its length, depending on the depth and swiftness of the water. Poles are placed on top and securely fastened with wire to those underneath.

The mat is launched over the end of the boat, leaving enough on the boat for splicing to the next length of the mat. The operations are repeated until the mat is of the desired length, which at times is several hundred feet. The mats vary in width, depending on the distance from water surface (about a 4-ft. stage) to toe of slope. The usual width is 20 to 30 ft. The construction of the revetment is shown in Fig. 7.

A barge loaded with rock is fastened to the bank at the upper end of the mat, the upper end of the barge being held close up to the bank and the lower end allowed to drift out, so as to sink the mat at an angle of about 30°. In this way the current has a tendency to force the mat both down and against the bank. As the mattress sinks the rock barge is slacked down to it. The mat is evenly covered with 6 to 12 in. of rock. From the water surface to top of bank rock alone is used, being carefully placed at a depth of 9 to 12 in. This is shown in Fig. 9.

The specifications for materials and for the measurement of the rock and brush are given herewith, somewhat condensed.

SPECIFICATIONS FOR ROCK AND BRUSH FOR MATTRESS WORK

ROCK—The rock must be hard, durable, and of a kind that will not disintegrate on exposure to the action of water or of the atmosphere, in pieces weighing from 5 to 100 lb.; 10% may be clean quarry spalls.

MEASURING ROCK—Barges must be evenly and compactly loaded. For each rock barge uniform width and length (expressed in integral number of feet) is secured by lines marked on the barge decks.

FIG. 9. ROCK REVETMENT OF BANK ABOVE WATER LINE

Ten heights along each side of load and ten through the center are taken. As the center measurements pertain to both sections of the load while the side measurements pertain to only one section, the former are given double weight in determining the average height of load. The sum of the 20 side measurements is added to double the sum of the 10 center measurements, and the total divided by 40 to obtain the average height, stated to 0.01 ft. The width, length and average height are multiplied together, and the product divided by 27 to obtain the contents in cubic yards; the result being stated to the nearest tenth of a cubic yard.

BRUSH—The brush shall be live and well trimmed, closely choked into bundles, full 20 ft. long, and from 9 to 12 in. diameter; tied with four bands of lath yarn of not more than 130 strands, or with wire not smaller than No. 18. Binding poles, properly trimmed, shall be furnished in the proportion of 50 poles for each 100 cu.yd. of brush, if required. These poles shall be piled in one end of the load, and will be measured and paid for as brush.

Fascines must be piled evenly and compactly, and so that the ends and butt side of load may be vertical and the length of the load along the bottom and top of both butts and tips may be the same. If the length of fascines is full 20 ft., it is taken as the width of load, though no allowance is made for fascines longer than 20 ft. Loads of fascines must be at least 6 ft. in average height.

MEASURING BRUSH — Measurements of length are taken at butt and top ends and averaged. Ten heights of load are taken, 3 at each end (1 at butts, 1 at tips and 1 intermediate) and 2 intermediate heights on both the butt and tip sides. The intermediate tip heights are taken by forcing the measuring pole down through the load to the deck of the barge. The sum of heights is divided by 10 to obtain the average, stated to the nearest 0.05 ft. The average length, height and width are multiplied together, and the product divided by 27 to obtain the contents in cubic yards, the result being stated to the nearest tenth of a cubic yard.

The average cost per cubic yard in place for the work shown in Fig. 1 is given in Table II; this work required 41,821 cu.yd. of rock and 72,028 cu.yd. of brush.

TABLE II. COST OF BRUSH AND ROCK MATTRESS

On barges (rock, $0.832; brush, $0.172)	$0.414
Towing	0.117
Putting in place	0.162
Local superintendence and office expense	0.018
General superintendence and office expense	0.011
Plant (rental charge)	0.069
Total	$0.791

During June, 1911, there were awarded seven contracts (aggregating $405,175) for the construction and repair of dams and shore protection on the upper Mississippi River. From each allotment 5% will be deducted to cover superintendence and inspection charges, and the number of cubic yards that can be placed under each allotment, as shown in Table III, is based on this 5% reduction. The ratio of rock to brush is 1 to 1½, except that for No. 5 it is 1:1.

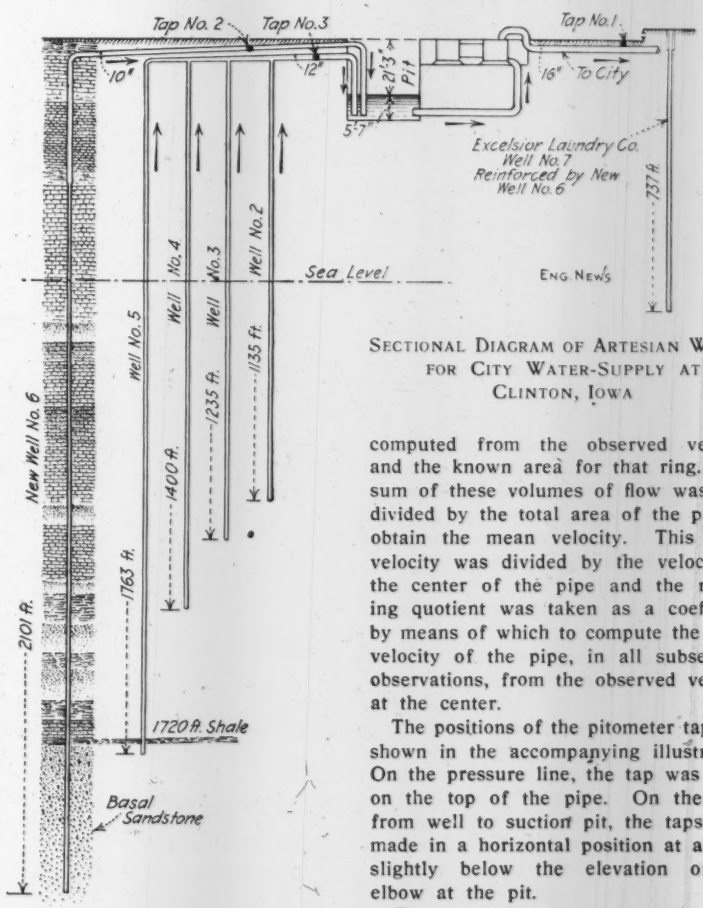
TABLE III. QUANTITIES AND PRICES OF CONTRACTS

	Net allotment $	Rock in place per cu.yd. $	Brush in place per cu.yd. Ct.	Aver. per cu.yd. in place $	Total material that can be placed Cu.yd.
Reads Landing to Alma	38,000	1.69	0.68	1.084	35,055
Genoa to Lynxville	38,000	1.68	0.68	1.08	35,185
McGregor to Dubuque	76,000	1.59	0.68	1.044	72,797
Rock Island to Muscatine	76,000	1.57	0.68	1.036	73,359
Sections 16-33, Flint Iowa River Levee	10,925	1.67	0.67	1.17	9,337
Keokuk to Hannibal	71,250	1.65	0.65	1.05	67,857
Hamburg to Cap au Gris	95,000	1.55	0.60	0.98	96,939

With a continuance of liberal appropriations, the volume of contract work will be increased. During six years in the '90's there were 180 bidders and 70 contracts awarded, aggregating $3,270,500. In 1911 there were only four bidders and contracts aggregating $405,175 were awarded. Probably there will be about $750,000 provided annually for contract work for the next ten years at least.

Pitometer Survey of Artesian Wells at Clinton, Iowa

Measurements of the flow of artesian wells for the city water supply of Clinton, Iowa, have been made to determine the effect upon the supply of a new well put into service early in 1911. These measurements are of particular interest in that they clearly show evidence of underground communication between the wells.



SECTIONAL DIAGRAM OF ARTESIAN WELLS FOR CITY WATER-SUPPLY AT CLINTON, IOWA

The accompanying illustration gives a more or less diagrammatic sectional view, indicating the geological formation and the relative depths of the wells. Wells Nos. 1 to 6, inclusive, are owned by the Clinton Water Co. No. 4, which is not shown in the illustration, was out of commission at the time the measurements were made. Wells Nos. 1, 2 and 3 reach the surface at elevations of between 20 and 21 ft., referred to city datum. The elevation of well No. 5 is 15.5 ft. and that of No. 6 is 23 ft. No. 7 is a well owned by the Excelsior Laundry Co. Its elevation is 25 ft.

The measurements of flow were made by means of a pitometer. The method used was practically the same as that explained in ENGINEERING NEWS, Feb. 5, 1903, p. 130, in connection with a description of the Cole-Flad photo-pitometer. The cross-sectional area of the pipe, the flow through which was to be measured, was divided into five rings and the velocity of flow at each ring was determined by means of the pitometer tube inserted through a 1-in. corporation cock in the wall of the pipe. The volume of flow through each ring was computed from the observed velocity and the known area for that ring. The sum of these volumes of flow was then divided by the total area of the pipe to obtain the mean velocity. This mean velocity was divided by the velocity at the center of the pipe and the resulting quotient was taken as a coefficient by means of which to compute the mean velocity of the pipe, in all subsequent observations, from the observed velocity at the center.

The positions of the pitometer taps are shown in the accompanying illustration. On the pressure line, the tap was made on the top of the pipe. On the lines from well to suction pit, the taps were made in a horizontal position at a point slightly below the elevation of the elbow at the pit.

The total flow from the old wells, Nos. 1, 2, 3 and 5, previous to the opening of the new well was about 1,170,000 gal per 24 hr. This was augmented by the boring of the new well by more than one million gallons per day, as shown in the accompanying table in the totals for Mar. 30 and Apr. 1. On Apr. 7, 1911, a separate measurement of the flow from the new well No. 6 alone gave a flow of over one million gallons per day. Measurements made on Apr. 11 showed that this flow had fallen off to 364,000 gal. per day and two days later the flow was observed to be only

about 346,000 gal. per day. It was found that the total combined flow from the old wells and the new was also decreased, but not to the same extent.

RATES OF FLOW OF ARTESIAN WELLS AT CLINTON, IOWA (GALS. PER 24 HOURS)

Date	Old wells Nos. 1, 2, 3 and 5	New well No. 6	Total flow Nos. 1, 2, 3, 5 and 6
July 27, 1910	1,169,289	.....	.....
Mar. 30, 1911	.....	.....	2,361,600
Apr. 1, 1911	.....	.....	2,185,920
Apr. 7, 1911	.....	1,002,204	.....
Apr. 11, 1911	1,526,400	364,320	1,785,600
Apr. 13, 1911	1,539,360	345,600	1,893,600

Measurements of the flow from the old wells Nos. 1, 2, 3 and 5 alone showed that this flow had been increased by about 370,000 gal. per day, but this increase was not enough to make up for the total decrease in the new well No. 6. From this it was concluded that 370,000 of the 650,000-gal. decrease in flow of No. 6 had gone to supply underground reinforcement to the flow of the old wells Nos. 1, 2, 3 and 5. The remainder of the loss from the new well No. 6, namely, 280,000 gal., must have gone to supply underground reinforcement to well No. 7, used by a private concern in the vicinity, and to other deep wells in the district.

This is explained by the fact that the new well No. 6 penetrates into the basal sandstone below the layer of shale at the 1720-ft. level, thus it taps a supply of water which is not reached by the other wells in the vicinity. Due to the fact that the new well is not cased, this new supply of water is allowed to spread out and reinforce the supply above the 1720-ft. level, increasing the flow of all the wells in the district.

The pitometer measurements were made by E. H. Converse & Co., 909 Empire Building, Pittsburg, Penn., to whom we are indebted for the information contained in this article. The results appear to support the contention of W. W. Norton, Special Assistant State Geologist of Iowa in charge of artesian wells, that artesian wells in the state should be cased in order to protect their flow.

Forests and Floods on the North Pacific Coast

By H. M. Chittenden*

Since the publication of my paper on the relation of forests to stream flow in the *Proceedings* of the American Society of Civil Engineers in September, 1908,† I have naturally watched with much interest for evidence tending to confirm or disprove its argument. The evidence which has come to me has been almost uniformly confirmatory, and some of it has been based upon more thorough investigation than has ever before been given to the subject. In this paper I wish to add some original data pertaining to a limited feature of the general subject, but the data are so clear and conclusive that they cannot fail to be of interest. I refer to the effect of the dense forests of the north Pacific Coast upon the floods resulting in part from the rapid melting of snow; and the data here presented relate to a flood in certain of the streams of western Washington in November, 1911.*

The topography of the west slope of the Cascades and of both slopes of the Olympic Range is steep and often precipitous, with little covering above rock on the steeper slopes. It is naturally a "quick spilling" territory, so far as mere topography is concerned, and one would confidently look for a quick response in run-off to any excessive rainfall. But this same territory is clothed with the densest forests on earth and with the heaviest covering of decayed vegetation—humus—and débris and underbrush that can be found anywhere outside the tropics. The conditions cited by the orthodox forester in support of his theory of the restraining influence of forests upon floods here exist in perfection, and it is here if anywhere that we should look for practical proof of such restraint.

Unfortunately for the theory the facts are the reverse of what it would lead one to expect. For suddenness and violence of freshets these forest streams exceed anything it has been my fortune to observe elsewhere. I have seen cloudbursts in the treeless regions east of the mountains produce quicker results, but never any ordinary storm, no matter how heavy or prolonged. The conclusion is inevitable that the forests themselves are in part responsible for this fact, and a study of the conditions as they actually exist shows that, even theoretically, this must be the case.

The result is produced largely by the action of the forests upon the distribution of snowfall—for all severe freshets in this region are produced by a combination of rainfall and snow melting. The effect upon run-off of precipitation in the form of snow (cold storage, so to speak) is to postpone the run-off to some period subsequent to that when the precipitation actually occurred. This precipitation is generally taken out of cold storage and converted into water simultaneously with additional precipitation in the form of rain, and thus the effects of two storms are added together.

But this does not measure the full effect of snow in intensifying freshets. Dry snow is a perfect sponge. It is impossible for rain to find its way through a thick layer of snow to the ground until the sponge has become so thoroughly soaked that it can hold no more. The effect of the snow is thus not only to postpone run-off to a period subsequent to that in which the precipitation occurred, but to drink up a vast quantity of liquid precipitation which would otherwise be flowing away, and to hold it until the retentive capacity of the snow is exhausted from the burden of the rain and its own melting.

The next step in the process is as if a mighty hand were to press down with tremendous force on the sponge, squeezing out the combined accumulation of water and converting the sponge itself into water at the same time. The snow thus not only adds two or more storms together, but it concentrates the last storm which does the melting into a much shorter period than that of the actual precipitation. The whole result is, of course, to intensify the run-off and there is no doubt that it often doubles and even quadruples effects normally attributable to the particular storm which ostensibly causes them.

Now, how do forests affect this process? Manifestly they accentuate all these effects by increasing uniformity of distribution of the snowfall. Forests break the force of winds and cause snow to fall in a practically uniform blanket on the ground, while in these dense woods of the Pacific Northwest immense quantities remain on the trees and underbrush from the extreme tops 200 ft. above the ground to the ground itself. It is obvious enough that in this condition all the effects above noted will be far more pronounced than if the snow were heaped into stupendous drifts as is the case in the open mountain country farther east. In the latter case the snow becomes a reservoir of incalculable value, husbanding the winter precipitation and dealing it out gradually far into the summer months. But in the dense forests this reservoir effect is utterly destroyed and in its place is substituted an intensifying effect upon floods which in some localities is the most striking characteristic of the run-off.

In this particular region where cold weather and deep snowfalls are invariably followed by heavy rains and warm winds (Chinooks) everything conspires to heighten these effects. The effects themselves and their direct relation to snow melting are well recognized by everyone though very few understand their theoretical explanation. The recent storm above referred to was an example. It was quite local in its severest development, but the conditions were typical. The maximum effect was on the Cedar River watershed, which furnishes the water supply of the city of Seattle. The fall rains had been light, there was little snow on the ground, and the ground itself was far from being soaked to its capacity, when, about the middle of November, 1911, a very heavy snowfall occurred in the mountains accompanied by an unusually low drop of the tempera-

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†Engineering News, Oct. 29, 1908, p. 467.

*Engineering News, Dec. 14, 1911, p. 706.

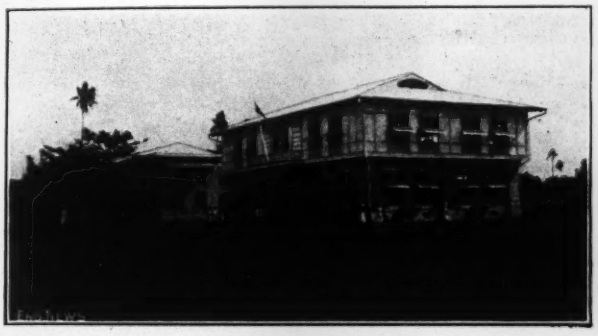
ture. In some places the temperature fell even to zero and nearly everywhere it was low enough to make the snow dry and floury—an ideal condition for drifting. Even at tide level in the city of Seattle the snow was still so dry two days after the storm that a sharp wind gave the atmosphere the appearance of a Dakota blizzard. There is no doubt whatever that if there had been no forests on the mountains the greater part of this immense snowfall, amounting in places to fully 7 ft., would have been heaped into the cañons and gullies or behind the shoulders of hills instead of being spread uniformly over the entire surface of the ground or hung up in vast quantities upon trees and underbrush. It is an entirely conservative estimate that the degree of exposure to heat, wind and rain, as things actually were, was at least a hundred times what it would have been if there had been no forests on these mountains.

Following this heavy snowfall and low temperature came the "Chinook" and the rains. The temperature rose to above 50° by the sixteenth. The rainfall was heavy, though by no means excessive, throughout the week following the period of lowest temperature, and an unusually large proportion of the run-off, which reached its maximum about Nov. 16, was unquestionably due to snow melting. It is interesting to note how observers recorded facts without understanding the full reasons for them. One observer said that in spite of the heavy rain the streams showed almost no rise for two days. Precisely, for during this time the thick sponge of snow drank up all the rain, which might otherwise have flowed harmlessly down the valleys, and held it and poured it all out with the next two or three days' rain and its own melting. The result is thus stated in the colorless official report of the Weather Bureau: "In the Cascade Mountains, in Washington, the unusually heavy snowfall melted rapidly with the warm rains of the sixteenth to the twentieth, and the enormous volume of water thus set free caused sudden and severe freshets in the rivers flowing to Puget Sound and the lower Columbia."

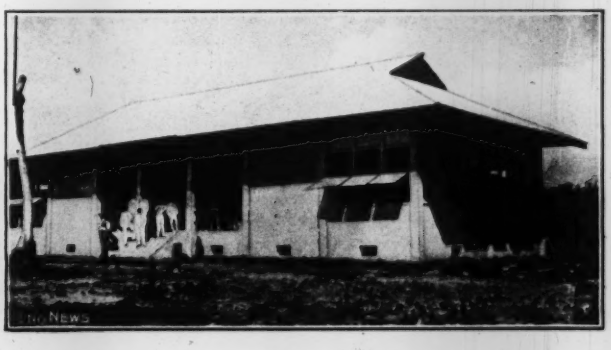
But why, it may be asked, does not the thick bed of humus in this virgin forest still exercise an important restraining influence upon these freshets. Mainly because it *is* a virgin forest. Through centuries of undisturbed conditions the water has worn its channels under logs and underbrush until it finds its way down the hills with not much more difficulty than in an open country. But when the woodman comes along and slashes down the forests and breaks up these time-worn channels and covers the ground with fresh débris, and induces the growth of new vegetation he increases enormously both the retentive power of the soil covering and its resistance to erosion. But in either case such covering ceases utterly to have any effect when once its capacity has reached its limit. A full vessel can hold no more.

The conditions on this coast are such as to give the theory above pointed out its most perfect application. But it is scarcely less applicable to the mountains of the interior with their scattered evergreen forests, though much less so to the low altitudes an ddeciduous forests of the East. Recent news items contain the following statements: Vast sums are to be spent by the government in reforesting Pike's Peak. "The effect of the new forests will be seen in a few years, according to experts. The trees and other vegetation will check the melting of the snow in the spring, thus distributing the spring floods through the dry months." Likewise in the "Blue Mountains in the Wenaha forest reserve in Washington" the government is about to plant extensive forests to increase the water supply for irrigation. And this is how it is to work out: "The snows of winter instead of melting with a rush, will be protected during that period and the water saved until mid-summer when it is usually needed."

The forests prevent the formation of those great reservoirs, the drifts. They delay melting during March, April and a part of May, concentrate it in latter May and early June, precipitate it all down the valleys in a very short period, causing the freshets commonly known as the "June rise," and leave the country entirely without snow-water supply during the dry months. In the open country the vast bulk of the snow is piled into drifts. In the open spaces where the snow is thin melting begins early, but is never very pronounced, and the drifts prolong it far into August and even in places through the entire summer. The forests concentrate the floods into brief periods with high intensity and leave the dry months without water. The open mountain country distributes the snow water over a much longer period, avoids the sharp-crested floods and prolongs the supply far into the summer. And yet, in spite of these demonstrable and demonstrated facts, a bureau of our government, which calls itself "scientific," openly advocates the spending of millions of dollars in planting mountain forests for the avowed purpose of "distributing the spring floods through the dry months"! There may be reasons sufficient to justify these expenditures, but that just cited is not one of them.



TACLOBAN HIGH SCHOOL; FIRST STORY CONCRETE; SECOND STORY, NATIVE LUMBER. GIRL'S DORMITORY IN BACKGROUND; COST, $13,600.



A 3-ROOM SCHOOL BUILDING AT BOBON, SAMAR; COST, $3760

Concrete School Buildings in the Philippines

In our issue of Nov. 30, 1911, p. 662, we noted that reinforced-concrete school buildings to the number of 231 are under construction in the Philippine Islands. J. C. Carpenter, assistant engineer of the Bureau of Public Works, Tacloban, P. I., sends us photographs of some of these buildings, two of which are reproduced herewith. As noted in our previous issue the buildings are constructed on standard plans, prepared for provincial, central and barrio schools. A unit system of building is adopted by which additional rooms may be added to the building as they may be required.

Widening a Pittsburg Bridge

The old Smithfield St. bridge over the Monongahela River, Pittsburg, was widened last summer by shifting one truss laterally. The delicate work was performed without accident. The bearing on the pier was kept at the old location by placing cantilever girders over the piers to carry the truss in its new position.

The Smithfield St. bridge over the Monongahela River at Pittsburg, Penn., is a structure of two spans of 357 ft. each, built in 1881. The trusses are lenticular, or double parabolic, with eye-bar bottom chord. The engineer for the bridge was Gustav Lindenthal. When he became connected with the work, however, the piers were already in existence; they were of masonry founded on timber cribwork, and had been built earlier for a proposed suspension bridge. In adapting his design to these piers it was necessary to build the piers 5 ft. higher. About ten years later the single roadway proved inadequate for the traffic, and the decision was reached to build a second roadway by adding a third truss upstream of the existing two. For this enlargement, carried out in 1891, Mr. Lindenthal was both engineer and contractor.

ADDING THE THIRD TRUSS, 1891—While the condition of the foundations of the old piers was not well adapted to enlargement, the decision was reached to extend these piers rather than remove them and rebuild. The extension was done by driving piles in the prolongation of the piers and founding the pier addition on the piles. That this work was satisfactory for moderate loading has been demonstrated by the fact that in twenty years' service the piers remained in good condition without appreciable cracking.

The first two trusses of the bridge were built at a spacing of 25 ft 8 in. c. to c. When the third truss was added upstream of the other two, it was set at a distance of 20 ft. 2 in. from the old upstream truss, thus leaving the new roadway 5½ ft. narrower than the original roadway.

The second roadway was built for the specific purpose of carrying the trolley line which was to be built to connect the main part of Pittsburg with the South Side; the old (west) roadway was to be kept for wagon and foot traffic. But the east roadway was too narrow to accommodate two lines of cars of reasonable width, and special narrow cars had to be provided for the bridge service; open cars could not be run, because of their extra width. These limitations of the bridge service, and the growing street-car traffic, had the effect that in 1903 the west roadway also was pressed into use, making a total of four tracks across the bridge.

The Smithfield St. bridge is one of the chief avenues of traffic to the South Side districts. The narrowness of the east roadway therefore made itself increasingly felt as an inconvenience, especially as vehicle traffic was excluded from this roadway. For half a dozen years past, projects for widening the east roadway have been under consideration. It was only two years ago, however, that these projects finally reached the stage of realization. Plans which had been drawn five years before were re-studied and reconsidered and bids were called for on these plans. The Fort Pitt Bridge Works, of Pittsburg, Penn., were the successful bidders. They executed the work during the season of 1911.

WIDENING THE EAST ROADWAY.

The widening as planned involved moving the easterly truss 4 ft. 6 in. upstream, i.e., outward, thereby widening the east roadway to a center-to-center spacing of 24 ft. 8 in., which is only 1 ft. narrower than the old roadway. The available length of the piers set a limit to the possible shifting of the truss, as it was not desired to build a further extension to the piers. In fact, the new position of the truss is so near the edge of the piers that in all projects for the widening it was planned to place longitudinal girders along each pier under the truss seat, extending from the center truss to the east truss and supporting the latter as a cantilever, with a shoe bearing practically at the old position of the upstream truss shoe.

ARRANGEMENT OF WORK—The work involved three piers and two 360-ft. spans, making a total length of steel-work of about 720 ft. to be shifted. The work was divided into four parts: (1) Placing the longitudinal girders over the piers under the truss shoes, forming not only the permanent cantilever support, but also providing a track upon which the trusses could be slid; (2) removing the floor, cutting the floorbeams, portal bracing and top-lateral bracing, and placing temporary bracing for holding the truss in position while shifting; (3) shifting

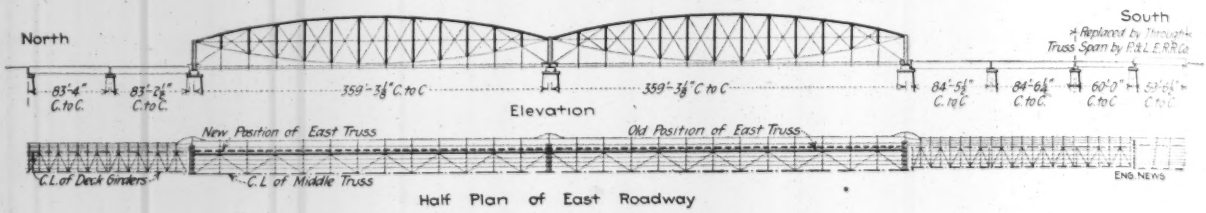


FIG. 1. OUTLINE SKETCH OF SMITHFIELD ST. BRIDGE OVER MONONGAHELA RIVER, PITTSBURG, PENN.

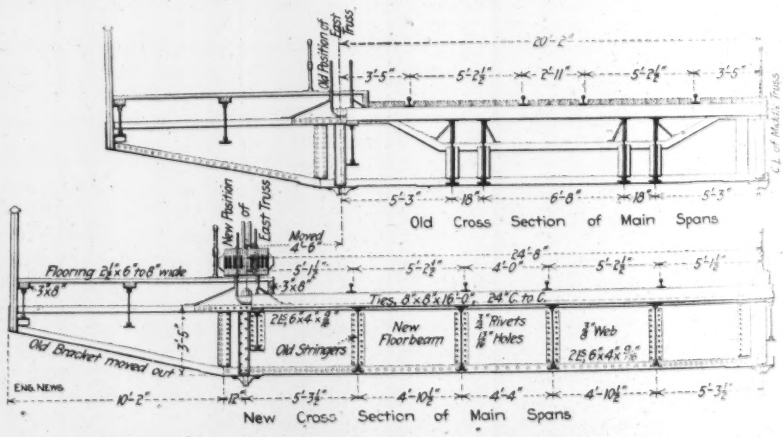


FIG. 2. SMITHFIELD ST. BRIDGE WIDENING; OLD AND NEW CROSS-SECTIONS OF EAST ROADWAY FLOOR IN RIVER SPANS

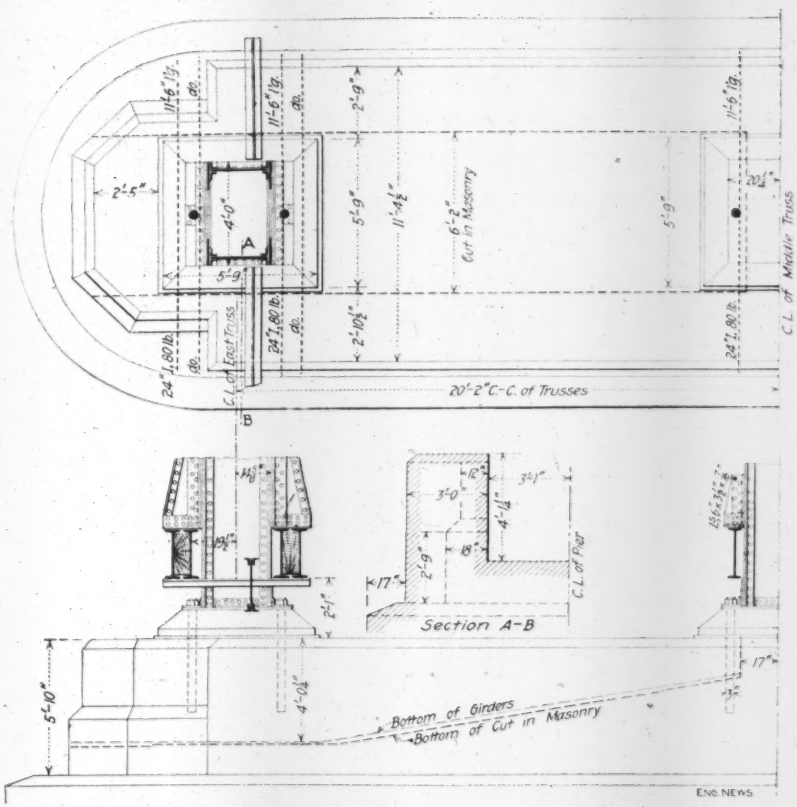


FIG. 3. SMITHFIELD ST. BRIDGE WIDENING; LOCATION OF CUT IN PIERS FOR CANTILEVER GIRDERS, AND JACKING BEAMS FOR END POSTS

the truss 4½ ft. laterally; (4) placing the new lateral and portal bracing and the new floor members.

The work involved not only the two river spans, but also several approach spans on either bank (see Fig. 1). The methods used for widening the approaches differed materially from the methods used in the river spans: the approaches were widened by change in the floor system only, without shifting of trusses. Further, in the south approach, which crosses the tracks and yard of the Pittsburg & Lake Erie Ry., the railway company desired to get rid of one of the piers and for this purpose offered to substitute a through truss span for two of the old deck spans, which offer was accepted by the city and the change executed by the railway company under the supervision of the city authorities.

The outline drawing Fig. 1 gives the chief characteristic of the structure, showing the form of the trusses in the two river spans and the arrangement of the girder spans in the approaches. It is to be remembered that the trusses had eyebar bottom chords and eyebar diagonals. The suspenders, by which the floorbeams are hung to the trusses, are also eyebars, but at the two middle panelpoints of each span the hangers are short and are built rigid, so that the trusses and floor are anchored to each other longitudinally. The stringer system of each span had sliding support at the shore piers, and fixed support over the center pier. The connection to the stringers was, in fact, the only longitudinal anchorage for the trusses. The nature of the floor construction may be seen by referring to Fig. 2, where the upper sketch represents the floor construction as it existed prior to the widening. The floorbeams had a depressed top flange, making the middle portion quite shallow, and the stringers were in pairs, with a view to possible operation of cable cars over the bridge; the space between the stringers over the floorbeams was intended to accommodate the cable, there being also provision for attaching a supporting roller between the stringers a short distance either side of each floorbeam. However, cable cars were never operated over the bridge.

The lower sketch in Fig. 2 shows the floor construction as it now exists, after the widening. As there appears, the stringer system has been rearranged, but the old stringers were used without change except the adaptation of new end connections. It was originally contemplated to use the old floorbeams, splicing in a section at the center. When the work was carried out, however, it developed that it would be cheaper to provide new floorbeams, and the floorbeams shown in the lower sketch of Fig. 2 are new throughout the bridge. The sidewalk brackets, however, are the original ones, being attached to the web of the new floorbeams. As will be noted farther on, the manner of reconstructing the floor in the approaches was quite different.

The method of adapting the piers to the new truss spacing is exhibited by Figs. 3 and 4. In both figures the middle pier is represented, but the operations were substantially the same at the two shore piers. The form and position of the five longitudinal girders placed on the pier under the truss shoes is seen in Fig. 4. Fig. 3 represents the original condition of the pier, except that the dotted

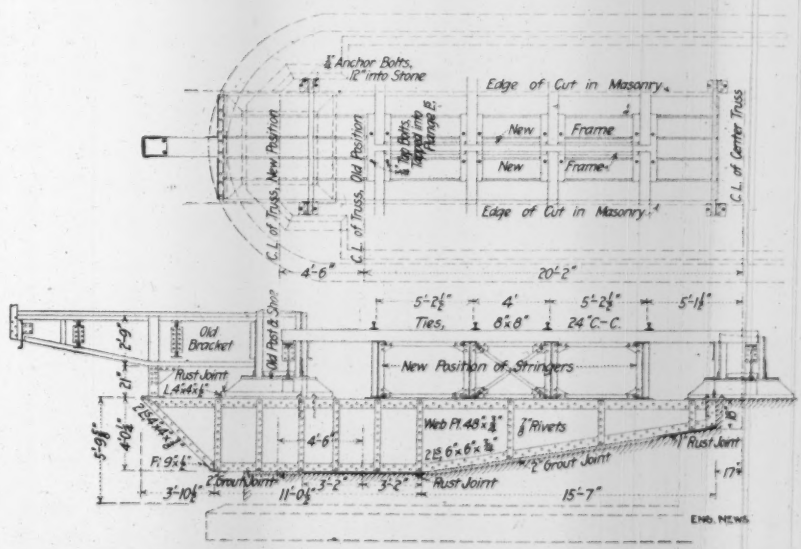


FIG. 4. SMITHFIELD ST. BRIDGE WIDENING; CANTILEVER GIRDERS, AND NEW ARRANGEMENT OF TRUSS AND STRINGERS AT RIVER PIERS

line in the elevation indicates the position of the girders and the dotted line in plan shows the cuts required to be made in the masonry to receive the girders; further, the jacking bracket and beams shown on the truss post were placed for the purposes of this work. It will be noted that the girders extend only a short distance under the shoe of the middle truss, the general bearing of this shoe being left undisturbed.

The method of placing the girders was as follows: An excavation was made in the top of the pier, approximately as indicated by the dotted line in the plan of pier top, Fig. 3, except that it extended only to the inner edge of the outer pier shoe instead of extending to the end of the pier. In cross-section this excavation is indicated in Section AA. The removal of the stone was done by chipping out the material, without the use of explosives. Meanwhile, the jacking bracket and longitudinal I-beams for the jacks were placed at the truss post as indicated in the elevation, Fig. 3. Two 50-ton jacks were set under each end of either pair of I-beams; subsequently, an additional jack was placed at each point of support, making twelve jacks at the center pier. As the plan in Fig. 3 indicates, the inner jack rested on the top of the pier while the outer jack bore on the belt course (the original coping) 5 ft. 10 in. lower down. When the jacks were placed the weight of the truss was taken off the shoes and transferred to blocking, resting on the undisturbed masonry outside of the intended line of excavation. Thereupon the excavation of the channel or pit for the longitudinal girders was continued under the shoe and to the end of the pier. As soon as this was completed the girders were slipped in endways and blocked to upward bearing against the shoe of the middle truss and to downward bearing directly under the original shoe of the east truss on wedges or shims for making a rust-joint bedding at this point. All other spaces under and around the girders were subsequently grouted with cement.

In the elevation in Fig. 4 the projecting end of the girder has the purpose of supporting the sidewalk bracket at the piers; this extension occurs only on the middle girder of the five. Also, the brace framing over the girder is special bracing put in place between the ends of the stringers, which at the pier do not have the support of the floorbeams and therefore require bracing to hold them upright.

The girders being supported at the old truss-seat, the pier is practically under the same load condition after the shifting of the truss as before, the load at the east bearing being but slightly increased by the change in location of the truss. Inasmuch as all spaces under the girders are grouted with cement grout, it is possible that the load reaches the pier at other points than merely over the length of the rust joints, but so far as load concentration near the end of the pier masonry is concerned, the pier is probably in just as favorable condition after the widening as before.

It was previously noted that the trusses were slid along on the top flanges of the girders as a track. To this end the girder tops were planed, and when lowering the truss shoes upon the girders heavy oil was applied.

While the pier work was in progress, the upstream truss was still connected to the other trusses by portal-bracing, lateral-bracing and the entire floor system. Before these could be removed, auxiliary bracing had to be placed. As shown by an inclined line in Fig. 1, longitudinal bracing struts were placed from each shoe to the first panel-point of the bottom chord to provide longitudinal stability. For lateral stability, a raking strut was put in, as shown by Fig. 5, at each end post. This strut and its bottom horizontal tie served also as the means for applying jacks for shifting the truss laterally. The construction of this brace frame and the method of anchoring it down to the flanges of the pier girders will be clear from an inspection of Fig. 5.

Before the widening, the bridge was braced by a full top-lateral system, portal frames, and intermediate sway frames at each panel-point. The sway frames extended down to the middle line of the truss. When these elements of lateral stability were removed, the trusses were without lateral support for their full length of 360 ft. between the end braces. A special top-chord system was devised, therefore, to hold the truss and to enable it to be held at all times while shifting it. The design of this system is the essential point of the method of moving the truss employed in the work.

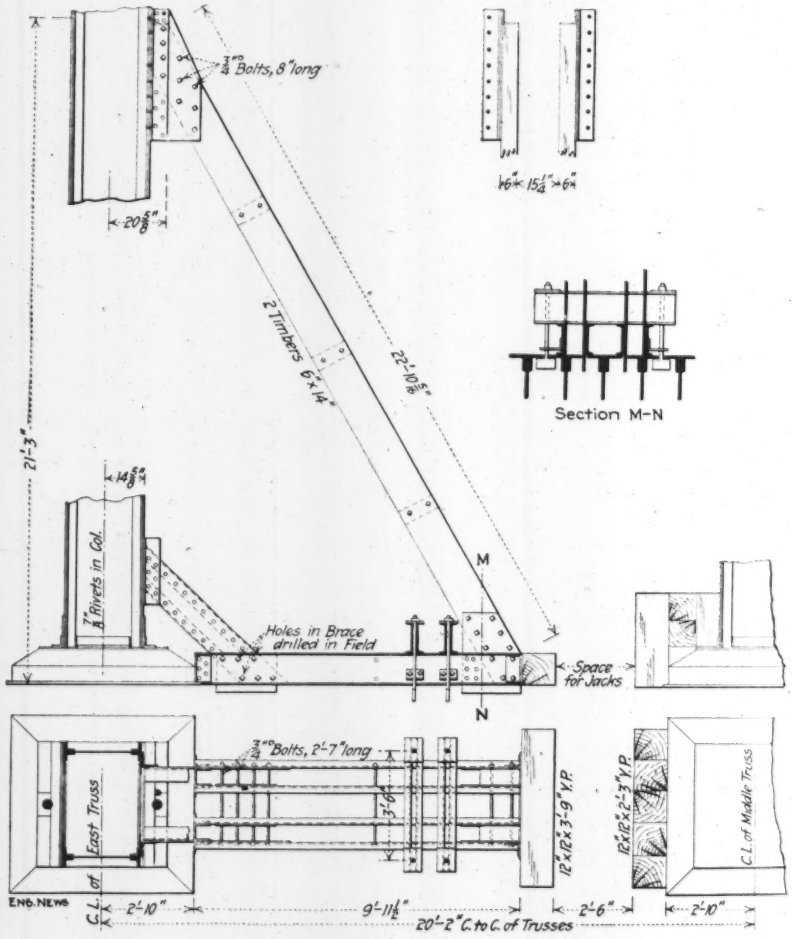


FIG. 5. SMITHFIELD ST. BRIDGE WIDENING; BRACE AND JACKING FRAME OVER RIVER PIERS

The bottom chord was left wholly without support in the way of bracing. There was some anxiety on the part of the contractors prior to beginning the moving whether the jacking, or the vibration from traffic on the undisturbed half of the bridge, or both causes acting together,

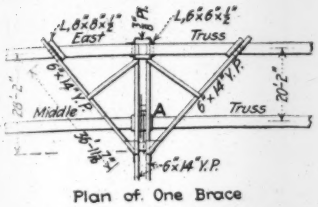


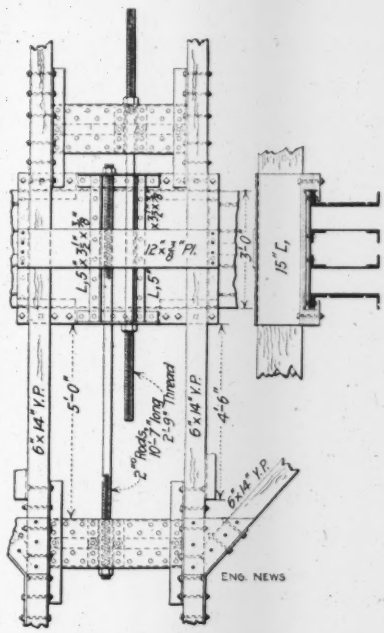
FIG. 6. SMITHFIELD ST. BRIDGE WIDENING; ADJUSTABLE BRACING IN PLANE OF TOP CHORD, FOR USE WHILE MOVING EAST TRUSS

might not set up a swinging motion in the loose bottom chord which might lead to disastrous results. To protect against such an occurrence, the middle two floorbeams in either river span were put in place, being fixed to the middle truss and hung in a yoke at the east truss; thus any vibratory or swinging motion of the truss would be opposed by the drag of the suspended floorbeams, which would amount practically to an anchorage against such motion, or at least against any great exaggeration of such motion. As a matter of fact, no swinging or cumulative vibration appeared in the truss, and the moving went forward without incident.

Fig. 6 shows in general arrangement and in detail the type of top-chord bracing adopted. A transverse strut and two diagonal braces were fastened to the top chord of the truss which was to be moved, extending over and lapping upon the top chord of the middle truss, which was held securely by the lateral system of the west half of the bridge. The timbers could slide over the middle truss, and they were connected to it by a pair of screws set in opposition so that before one screw could be drawn up the other had to be slacked off. On studying this arrangement, it will be seen that it forms a complete bracing system from the middle truss to the east truss when the screws are drawn up tight, but that by slacking off one screw and drawing up the other the frame and east truss could move outward.

Each of the two spans was fitted with four of these adjustable braces, spaced three top-lateral bays apart. These four struts supported laterally the twelve intermediate top-chord panel-points. The ends of the top chord were supported laterally by a transverse strut provided with an adjusting device similar to that of the intermediate struts.

The conditions governing the moving of the trusses were as follows: The two trusses were supported on the three shoes, one on each pier, and these shoes rested on the oiled girders as tracks. The brace frames provided at the shoes as shown in Fig. 5 gave a means for applying the jacks for shoving the truss over, the jacks being placed between the heel of the brace frame and the shoe of the



Detail at Point A

middle truss. Except at the shoes, both spans were quite free, held only by the adjustable top-chord bracing just described and the floorbeams at midspan. The moving, therefore, required the operation of the jack at the three shoes and the manipulation of the adjusting screws of the top-chord bracing; the floorbeams in their suspension yokes took care of themselves.

To do this work, men were provided at the piers to handle the jacks and one man was stationed at each top-chord adjusting point. A system of signals was agreed upon by which the men could know when a given movement had been obtained, or was to be obtained. The general plan of working was to obtain successive movements of one-quarter inch. When a movement of ¼ in. was obtained at the three jacking points, a pause was to be made until signals had been received from all of the top-chord men that they had shifted their adjusting screws an equal amount, this meaning, of course, that the truss was in correct line on its full length. As a matter of fact, the movement did not progress in a series of separate stages as the plan would imply, but was practically continuous. After the first beginning of the work, the men at the adjusting screws had a sufficiently good judgment of the rate of moving to keep their work on the adjusting screws about abreast of the movement of the jacks, and the signal that the ¼-in. movement had been obtained was received practically at the same time along the whole length of the bridge.

The procedure as described went through without a hitch, and at a remarkably rapid pace. The actual moving of the truss was accomplished in less than three hours. Counting the preparation for the work (posting the men at the several positions and instructing them in signals, etc.) an entire day was consumed, but the trusses were in motion only the time stated and by the end of the day they had been made secure by a sufficient amount of bracing and other connections to relieve the contractor of any possible anxiety as to the stability of the structure.

The work from this point forward was simple. The new floorbeams were put in, top-chord and portal bracing placed, and then the stringers riveted between the floorbeams. Putting on a new wooden deck, etc., was a separate contract.

In renewing the bracing, floorbeams and stringers, it was found that the old stringers could be used economically, re-

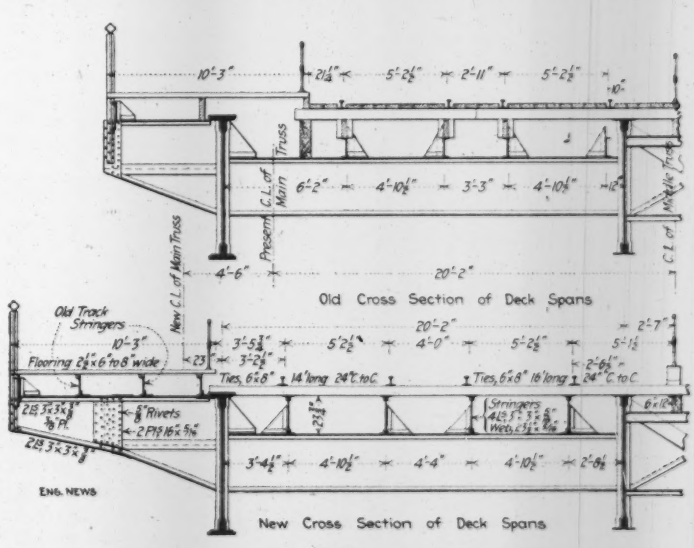

Old Cross Section of Deck Spans
Old Track Stringers
Flooring 2½"x6" to 8" wide
Ties, 6"x8" 14' long 24" C. to C.
Ties, 6"x8" 18' long 24" C. to C.
6" Rivets
ENG. NEWS
New Cross Section of Deck Spans

FIG. 7. SMITHFIELD ST. BRIDGE WIDENING; OLD AND NEW CROSS-SECTIONS OF EAST ROADWAY FLOOR ON APPROACHES

quiring only a little change at the ends to fit them for connection to the floorbeams. The floorbeams, as already noted, are new, the old ones being scrapped. The top lateral bracing has new struts, but the old diagonal rods were used, with suitable end extensions. The sway frames also are new. The portal bracing, consisting of top and bottom struts and a web system of angles, was utilized by cutting in the middle and splicing in a new section. These various repairs were done without special difficulty, and the finished work has satisfactory appearance in all respects.

Considerable repajr work was necessary at the details over the pier. The feet of the end posts and the shoes were not badly corroded, in spite of having large accumulation of rubbish about them, but the stringers in line of the middle and east trusses, which were web-connected to the face of the end posts of either truss, had crushed in the web plate, or rather the batten plate, of the end post, so that these plates had to be cut out and new ones put in.

Widening the Approaches

Fig. 7 shows cross-sections of the approach spans in the old and in the rebuilt condition. The spans consisted of deck plate-girders, except that the most southerly one of the south approach was a half-through plate-girder. Referring to the old condition (upper sketch in Fig. 7), it will be seen that the peculiar construction of the sidewalk brackets made it possible to extend these brackets by adding on another section, and thus widen the sidewalk the required amount. Further, the two girders were not in line with the trusses of the river span, nor in line with the new position of the trusses, but were about halfway between. Since the floor lay wholly above the girders, no truss or girder clearance was involved, and the width available from center line of approach to outer girder was about equal to the new net width on the river spans. These conditions made it unnecessary to shift the approach girders, but it was sufficient to reconstruct the floor. The sketches in Fig. 7 show how this was done.

The essential item in the reconstruction was the provision of new roadway stringers of greater capacity and at different locations, and the use of the old roadway stringers for sidewalk stringers. This work was executed with little trouble and no difficulty.

The cost of the entire widening work, including river spans and approaches, was about $60,000. The work was done by the Fort Pitt Bridge Works, of Pittsburg, Penn., H. R. Blickle, Chief Engineer; Chas. G. Schade, Assistant Engineer, and W. P. Rothrock, Engineer of Erection. It was under the direction of the Bureau of Construction, Department of Public Works, of Pittsburg; N. S. Sprague, Chief Engineer. Willis Whited was Engineer of Bridges in the Bureau during the larger part of the time. He was succeeded by T. J. Wilkerson as acting Bridge Engineer.

Condition of the River Piers

As has already been noted, the piers were lengthened in 1891 to accommodate the second roadway, and the original portion has a foundation of different character from that of the extension. In spite of the heterogeneous character of the foundation, the piers remained intact and showed no cracks or other evidences of weakness for many years. Five years after the second roadway was added, the city had a committee of engineers, Messrs. Herman Laub, C. C. Schneider and James B. Andrews, inspect the bridge to determine its condition. This committee found the piers to be in perfect shape. The city engineer of bridges inspected the structure carefully as late as a dozen years after that time, and also found the piers in perfect condition.

In the last few years, however, cracks have made their appearance in the river piers. They have been particularly noted within the past year, that is to say during and after the widening above described. The middle pier is in the most unfavorable condition, having a transverse crack at or near the middle line, extending from the coping down to water level. It is conceded that this crack is an evidence of differential settlement of the original and the extension foundation. The city authorities do not regard the situation as serious, however, and they limit themselves to keeping the pier under regular observation to note any changes. The bridge is now carrying its full traffic load.

Construction Cost of the Sewage Purification Works at Washington, Penn.

By Donald M. Belcher*

The sewage-purification works for Washington, Penn., were built in 1907-8, and were described, in detail, in Engineering News of July 16, 1908. The purpose of this article is to give the cost of construction of the different structures. The cost figures will be better understood after giving an outline of the works.

Type and Capacity—The purification plant consists of septic tanks, sprinkling filters and settling basins and has a capacity of 3,000,000 gal. of sewage per 24 hours. It is located about three miles below Washington, on the Chartiers Creek, near Arden Station. Details of the design of the various structures were given in the above mentioned article.

Screen Chamber—The sewage first enters the screen chamber, which is situated on the opposite side of the creek from the rest of the purification works. This chamber is open and divided into two sections, each of which may be shut off by stop planks. The sewage passes through two screens, the first having openings of ⅜ in. and the second openings of ¼ in.

Suction Conduit—The sewage passes under the creek, through a 16-in. cast-iron inverted siphon, and flows, by gravity, to the pumping station, in a conduit consisting of 20-in. vitrified pipe laid in concrete.

Pumping Station—The building is of pressed brick with sandstone trimmings, resting on concrete foundation walls, which form the lower portion of the station, in which the machinery is located. The roof is of slate carried by steel trusses.

Under pumping machinery is included one 25-hp. and two 15-hp. Gardner gas engines, one 8-in. and three 5-in. Brooks centrifugal pumps and all piping, valves and appurtenances in the pump pit. The gas engines (made by a local company) are of horizontal, single-cylinder, two-cycle type and are fitted with hot tube ignition and compressed-air starting devices. The 5-in. and one 8-in. sewage pumps have a combined maximum rated capacity of 5,040,000 gal. per 24 hours, against a head of 20 ft., and the 5-in. sludge pump has a maximum rated capacity of 1,080,000 gal. per 24 hours, against a 7-ft. head.

The water supply, to furnish water for cooling the gas engines and for flushing purposes, is obtained from two wells which were driven near the station. The water is lifted from these wells by compressed air into a suction well, of 16,500 gal. capacity, just outside of the station, and pumped from this into a concrete storage tank, situated on rising ground about 175 ft. from the station. This tank has a capacity of 4000 gal. and is 13 ft. above the gas engines.

Under this item is included the cost of drilling two wells (125 ft. deep); a 20-hp. Gardner gas engine; a Gould triplex pump of 150 gal. per min. capacity; a Hall air compressor having a capacity of

TABLE I. UNIT PRICES, SEWAGE PURIFICATION WORKS, WASHINGTON, PENN.

	Quantity	Unit price
Excavation	14,730 cu.yd.	$0.28
Concrete, roofs, 1:2:4	353 cu.yd.	11.00
reinforced walls and walls having a minimum dimension of 12 in. or less, 1:2:4	1,280 cu.yd.	7.40
heavy walls and foundations, 1:2½:5½	1,517 cu.yd.	7.00
floors, 1:2½:5½	1,412 cu.yd.	6.00
Ransome twisted steel reinforcement	30.5 tons	45.00
Cast iron pipe	56.5 tons	50.00
Special castings, bell and spigot	6.1 tons	85.00
Special castings, flanged	8.8 tons	105.00
Broken stone filtering material, local	13,730 cu.yd.	1.20
Broken stone filtering material shipped in	1,135 cu.yd.	1.60

*14 Prospect St., Winchester, Mass.

TABLE II. COSTS OF VARIOUS PARTS OF THE SEWAGE PURIFICATION WORKS, WASHINGTON, PENN.

Land	17 acres		$14,000
Screen chamber	826 cu.ft.		323
Suction conduit:			
16-in. c.i. siphon	80 lin.ft.	$830	
20-in. suction line	257 lin.ft.	1,179	2,009
Pumping station, 28x50 ft.			
Building, substructure	22,300 cu.ft.	2,908	
Building, superstructure	25,200 cu.ft.	5,184	8,092
Machinery, engines and pumps		4,827	
Machinery, water supply		3,823	8,650
14-in. c.i. force main	385 lin.ft		1,070
Septic tanks, 800,000 gal.:			
Earthwork, average cut	10.5 ft.	1,379	
Concrete	1,204 cu.yd.	9,087	
Steel reinforcement	16.5 tons	743	
Valves, pipes, etc.		2,700	13,909
Dosing chamber	630 cu.ft.		382
20-in. c.i. conduit to filters	190 lin.ft.		765
Sprinkling filters	1.5 acres		
Earthwork, average cut	1.5 ft.	1,341	
Concrete walls	454 cu.yd.	3,636	
Flushing galleries	56,700 cu.ft.	8,376	
Distributing system		9,578	
Collecting system		8,806	
Filtering material	14,865 cu.yd.	18,324	
Miscellaneous		238	50,299
Settling basin, 160,000 gal.			
Earthwork		500	
Concrete	164 cu.yd.	1,099	
Valves, pipes, etc.		293	1,892
18-in. outfall conduit	165 lin.ft.		314
Sludge disposal			
Drying area	1.5 acres	762	
18-in. drain from septic tanks	416 lin.ft.	652	
10-in. drain from settling basin	165 lin.ft.	289	
6-in. c.i. force main	202 lin.ft.	148	1,851
4-in. c.i. water main	430 lin.ft.		227
Miscellaneous			1,045
Total cost (exclusive of engineering)			$104,828
Engineering, 10.1%			10,594
Total cost			$115,422

50 cu.ft. of air per min., against 50 lb. pressure; an air receiver, 2 ft. in diameter by 8 ft. long; air piping to the wells; concrete suction well and storage tank; 4-in. cast-iron pipe line between the station and the storage tank and the necessary valves, piping and appurtenances in the station.

SEPTIC TANKS—The sewage is lifted approximately 20 ft., through a 14-in. cast-iron main, into the septic tanks. Four compartments are formed, by reinforced-concrete dividing walls, each being 25x100 ft. in plan and 11 ft. deep, and they are covered by a 4-in. flat reinforced-concrete roof, carried on beams and piers. Adjacent to the tanks is a small uncovered dosing chamber in which is a float operating a butterfly valve which automatically controls the flow of sewage from the septic tanks to the filters.

From the dosing chamber the sewage flows, by gravity, through a 20-in. cast-iron pipe line to the sprinkling filters.

SPRINKLING FILTERS—The filters are four in number, each being 100x150 ft. in plan, and are surrounded by concrete walls on all sides. Along both sides of each filter are covered galleries, 4 ft. wide and 6 ft. high, and into these extend the ends of the tile underdrains. A 4-in. cast-iron water main runs the length of each gallery to provide for flushing.

The main distributors consist of 15-in. vitrified pipe embedded in the walls of the central gallery and the lateral distributors are 5-in. vitrified pipe carried in the top of small concrete walls.

Five-inch half-tile, laid on a 4-in. concrete floor, form the lateral collectors. The main collectors, which are built of concrete, run the length of each filter and empty into the effluent conduit, which is formed by vitrified pipe embedded in the walls.

The broken-stone filtering material, except the upper 6 in., was taken from a local quarry and was a low-grade limestone, very close grained and hard, but liable to crumble when exposed directly to snow and ice. For this reason, a better grade of limestone, from Ohio, was used for the upper 6 in. Two sizes of stone were used, the larger being 2½ to 4 in. and the smaller 1 to 2½ in. The average depth was 6 ft. 10 in.

SETTLING BASIN—This is an open basin, with concrete walls and floor, divided into two parts for purposes of cleaning. The sewage passes out of the basin over a weir and flows by gravity through an 18-in. vitrified pipe, to the creek. There is a flap gate at the end of the pipe protected by a concrete headwall.

SLUDGE DISPOSAL—An area of about one and one-half acres was graded and underdrained to provide a drying area for the sludge.

The sludge from the septic tanks flows to the disposal area by gravity, through an 18-in. vitrified pipe line. The sludge from the settling basins flows through a 10-in. vitrified pipe, laid in concrete, to the pumping station and is pumped from there through a 6-in. cast-iron force main to the drying area.

UNIT PRICES—In Table No. I are given the unit prices of the principal items.

Stone for the concrete was taken from a quarry located about 1000 ft. from the plant. The sand was Ohio River sand and was mixed with the crusher dust in equal parts.

COSTS—The costs of all the structures are given in Table II. These costs are the total costs of the work to the Borough of Washington and not the actual cost to the contractors. In apportioning the costs to the different structures, all pipes, valves, etc., inside of the outside neat lines of each structure, were considered to belong to that structure.

UNIT COSTS—In Table III are given the unit costs of some of the structures, based on their capacities.

It is estimated that the present purification works will treat the sewage from a population of about 40,000 and the per capita costs, in the following table, are based on this figure.

	Cost of construction	Cost per capita
Pumping station and works preparatory to purification plant	$20,251	$0.51
Purification plant	70,577	1.76
Total purification works (exclusive of land and engineering)	90,828	2.27
Total (including land and engineering)	115,422	2.89

CONTRACTORS—The sewage works were designed by R. Winthrop Pratt, of Columbus, Ohio, and built under his supervision, with the writer as resident engineer. The general contractors for the work were Williams, Proctor & Potts, Inc., of New York City. The water-supply machinery was installed, under a separate contract, by the Reineke-Wagner Pump & Supply Co., of Pittsburg, Penn.

The construction work was commenced in March, 1907, and the plant was finished and put in operation in February, 1909.

TABLE III. UNIT COSTS OF STRUCTURES COMPOSING SEWAGE-PURIFICATION WORKS, WASHINGTON, PENN.

	Capacity	Unit price	
Pumping station building, substructure	22,300 cu.ft.	$0.13 per cu.ft.	
superstructure	25,200 cu.ft.	0.21 per cu.ft.	
total	47,500 cu.ft.	0.17 per cu.ft.	
Septic tanks	800,000 gal.	$17,380 per 1,000,000 gal.	
Sprinkling filters	1.5 acres	$33,530 per acre	
Settling basin	160,000 gal.	11,820 per 1,000,000 gal.	
Screen chamber	3,000,000	$108	per
Suction conduit		670	
Pumping station	gallons	5,580	1,000,000
Force main		357	
Purification plant:	per		gallons
Septic tanks		4,636	
Dosing chamber		127	
Conduit to filters	24 hours	255	per
Sprinkling filters		16,766	
Settling basin		630	24 hours
Outfall		105	
Sludge disposal		617	
Water main		76	
Miscellaneous		314	
Total purification plant		$23,526	
Total purification works (except land and engineering)		30,276	
Total purification works (including land and engineering)		38,474	

Surveys for a Submarine Rapid Transit Tunnel*

By Frederick C. Noble†

The following is a description of the surveying methods used in constructing the tunnel under the East River (at New York) between South Ferry, Manhattan, and Joralemon St., Brooklyn. This tunnel was begun in March, 1903, and was opened to traffic in January, 1908. The tunnel consists of two parallel single-track tubes, of the usual cast-iron ring construction having an interior diameter of 15½ ft. The distance between centers is 28 ft. under the river and 26 ft. in Joralemon St. The Manhattan headings were driven from a double shaft in Battery Park. The Brooklyn headings were driven from two shafts (one over each tube) in Joralemon St., about 1200 ft. from the water front. Between the shafts, a distance of about 6000 ft., there are three tangents in the tunnel line, the middle or river tangent being joined to the Manhattan and Brooklyn tangents by curves of 4500 ft. radius (Fig. 1).

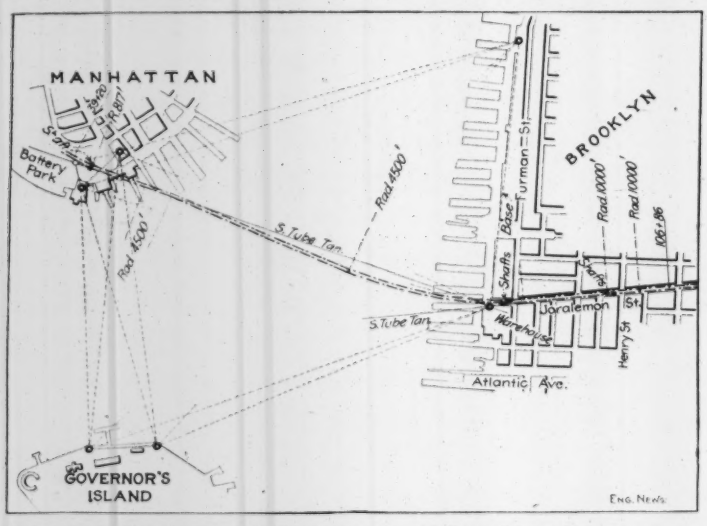


Fig. 1. Plan of Triangulation Survey for the East River Tunnel from the Battery (New York) to Brooklyn

The intersection of the south tube lines of the Joralemon St. tangent and the Manhattan tangent produced was located on the roof of a dock warehouse at the foot of Joralemon St. It was necessary to determine the exact distance between this intersection and a point of known stationing on the south tube line in Manhattan, and this required a triangulation survey. It was apparent that no base line of suitable length could be laid out in the vicinity that could be measured directly from end to end as one of the sides of the triangulation system. Although the ends could be located on roofs, so as to be seen from each other, the measurement had to be made along a broken line.

A reconnaissance showed that a practicable base, about 3000 ft. long, might be obtained on the Brooklyn waterfront north of Joralemon St. The southern terminus was chosen to be the above-mentioned intersection of the south tube lines, and the northern terminus was also located on the roof of a warehouse. Each of these points commanded a view of the other and of the adjoining waterfronts of Manhattan and Governor's Island, and, accordingly, were suitable for triangulation stations. In Manhattan, because of intervening buildings, it was found impracticable to locate a triangulation station on the south tube line in the vicinity of the shaft so that it would be visible from all the other stations. On this account two elevated points on the roofs of near-by buildings, one on each side of the Manhattan tangent, were chosen as triangulation stations, and carefully referenced to the point of known stationing on the south tube line, which was visible from them. On Governor's Island, on the northerly sea-wall, two triangulation stations were chosen which marked the extremities of a shorter base used two seasons before in making a preliminary triangulation of the tunnel line. It was desired to include this base in the system so as to have an independent check on the Brooklyn base measurement.

The foregoing arrangement gave four fairly well proportioned quadrilaterals, the Brooklyn base forming one common side. In the system there were no angles of less than 26° or more than [illegible], and the ratio of length of base to the distance sought was about 1:1½. By having four quadrilaterals from which to calculate the coördinates of the Manhattan points, referred to the Brooklyn base as the axis, it was thought that any material error in the angular work could be detected, and this would give a measure of the error to be regarded as unavoidable.

The base line traverse was measured with a 50-ft., flat, steel-wire tape, provided with a spring-balance handle containing a level bubble, thermometer, and adjustment for temperature correction. It was marked with nicks at each end for use with plumb-bobs. The tape was tested for absolute length by comparison with a standard tape of known error, as determined by the Bureau of Standards at Washington. Measurements were made on cloudy days, or during early mornings in the shade, to secure uniform temperature conditions. The line was marked in advance every 50 ft., and paper pads, ruled with a longitudinal line, were weighted down at these points, so as to relieve the head chainman of the distraction of getting line from a transit. Each measurement was made by simultaneous plumbings at the ends of the tape, which was held level. The forward point was marked at the average of a number of trials. For each series of measurements a fresh sheet of the pad was used. With a tape of this kind the difficulty of steady and precise plumbing was such that no individual measurement could be depended on to less than 0.003 ft., or 1 in 17,000.

No doubt a better method consists in using a longer tape, supported at short intervals, with a tape-stretcher; and measuring directly, without plumbing, on portable stations, as was done later in connection with other tunnel surveys in New York. However, with care, it was found that the errors were not cumulative, and, in a distance of 2880 ft. measured in this way, the variation between the mean and the greatest extreme of several measurements was only about 1 in 100,000. The ends of the line measured on the docks were connected to the triangulation stations on the roofs in two different ways, in order to avoid repeating an error. The points on the copings were transferred to the dock level by casting down intersecting lines of sight from three transit set-ups. As a further check, an independent traverse, closing on the same points, was run by a different party in the marginal street back of the warehouses, and this gave a result agreeing with the dock traverse to 1 in 150,000.

The triangulation sights were octagonal pine poles, 2¼ in. diameter and 8 ft. high, painted in alternate bands of red and white. These could be bisected readily, and gave no sensible difficulty from phase, because of the comparatively

*Abstract of a paper (copyright) presented before the American Society of Civil Engineers (New York), Feb. 7, 1912. The paper is entitled, "Notes on a Tunnel Survey," by Frederick C. Noble, and is published in the December issue of the "Proceedings" of the Society (p. 1302).

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‡Engineering News, 1906, I, 611; 1907, I, 717; 1907, II, 35, 312; 1908, I, 463, 512.

short range and the cloudy weather selected for instrumental work; but it would have been better practice to use higher targets with wide, flat vanes, set alternately at right angles.

The angles were read separately by two observers, with different instruments. These were ordinary engineers' transits, reading to 20 sec. on a 6¼-in. limb. The eight angles of a quadrilateral were measured separately by successive additions upon the limb. The entire angle at a station was also read, as a check on the sum of its components. To avoid bias, the angles were started at random near zero. Turnings were made, accumulating from left to right, until the sum became as nearly as practicable 360°, or its multiple. Reversing the telescope, and setting on the right-hand target, the same number of turnings was made from right to left until the sum was diminished to near the original reading. Both verniers were read at the beginning, at the middle, at intermediate points, and at closing. In case an angle failed to close nearer than an average of 4 sec. to each turning, the result was discarded and the angle was read again.

When the third angle of any triangle of the system had been read, the angles were added, and if their sum varied from 180° by more than an average of 5 sec. for each angle, the three angles were read again. The quadrilaterals were tested in like manner. It was found necessary to read over only one triangle, and in this case the trouble was located at a station where the conditions for observing had been less favorable than elsewhere.

In comparing the observed angles, it was noted that the direct reading of an angle was generally greater (by 2 or 3 sec.) than its value as found by taking the difference between two angles; and that, at the end of an observation, the closing reading was nearly always greater than the first. As this pointed to a small persistent error, it was seen that it would have been a better program to measure each angle both directly and by its 360° complement, and to take the mean.

The set of observed angles of each quadrilateral was adjusted by the method of logarithmic residuals, based on the principle of least squares, according to Johnson, and using the rigid method of making the side equation correction. The angles read by each observer were adjusted separately. The corrections for spherical excess and reduction to sea-level were omitted as insignificant.

The four quadrilaterals formed four pairs, each with a common triangle. These relations would give rise to additional equations of condition, and the simultaneous adjustment of all four quadrilaterals would be possible, theoretically. However, this was not attempted because the refinement would not pay for the effort, and because it was desired to compute each quadrilateral separately adjusted, so as to gain a practical idea of the effects of error in the angular work.

For the purpose of comparing results, the coördinates of the Manhattan and Governor's Island stations, referred to the Brooklyn base, were then computed for each of the four adjusted quadrilaterals of each observer. On plotting to full size it was found that for any point the various positions thus computed fell within the section of the target pole. It was seen that considerable time and labor would have been saved (and with sufficiently accurate results) by using any one quadrilateral, but the advantage of learning in this way the probable extent of errors from all causes was thought to warrant the extra trouble.

The sides of the triangle formed by the two Manhattan triangulation stations and the point of known stationing in Battery Park were then measured, and the coördinates of the latter point were computed from those of the other two. The distance triangulated for was then determined. The computed length of the Governor's Island base (about 700 ft.) was found to agree with its original measured length within 0.016 ft., or much less than the probable angular error would account for.

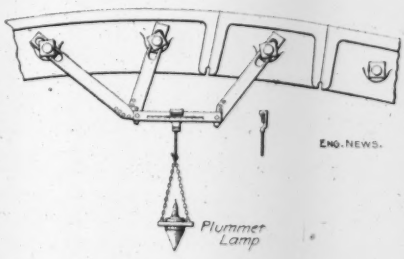

FIG. 2. SCALE FOR ALIGNMENT OF TUNNEL

The stationing of the Brooklyn intersection of the south tube tangents then being known, base-tape measurements were made from this point to the Brooklyn shafts. Stationing was transferred to the tunnel by plumbing in the shafts. All measurements, above and below ground, to determine stationing in the tubes, were made with the same kind of tape as that used for measuring the base, and in a similar manner. When the first headings were connected, the measured distance was found to be about 0.02 ft. short of that calculated. The discrepancy was somewhat more than had been expected, but may be adequately accounted for as combining the error in angular work with the error due to the difference in conditions, with the apparatus used, between taping in the tunnel and taping the base line on the surface. Its effect on the results of the surveys for alignment and grade, however, was very slight.

For establishing the Manhattan tangent alignment, there was no point on line in Battery Park, near the shaft, that was high enough to afford a sight to Brooklyn over the intervening ferry houses. For this purpose, two towers, about 35 ft. high, one on each tube line, were erected about 150 ft. west of the shaft. From these it was possible to look across the river over all obstructions and see targets on the warehouse roof in Brooklyn set on the Manhattan tube lines prolonged. The towers were built as triangulation towers usually are: with an interior tripod of three 8x8-in. timbers rigidly bolted together at the top and braced. This was inclosed within, but nowhere touching, a four-post tower braced on all sides and supporting a platform for the observer a little below the top of the tripod.

GIVING LINE IN THE TUNNEL

Line was transferred to the tunnel in the following manner: A transit, mounted on a trivet, was set on the tower tripod on the tube center line, as plumbed up from a hub under the tripod by several reversals of another transit set on the center line a short distance away. The tower transit, fore-sighting on the Brooklyn target, set (by repeated plungings) a point on center line on the surface, about 10 ft. beyond the shaft. On this point a transit was set up, with its plumb-string in the mean position of the several settings; then, fore-sighting on the plumb-string of the tower transit, it aligned two plumb-wires suspended in the shaft.

Steel piano wire, $\frac{1}{50}$ in. diameter, was used for this purpose. It was wound on brass reels 9 in. diameter. The reels were set, with their axes across the line, on stringers attached to the head-frame posts, high enough to permit sighting on the wires and to fore-sight by merely changing the focus. As the wire left the reel it ran over a small grooved wheel on a threaded axis, turned with a thumb-screw, by which slow lateral adjustment could be given. The wire was kept taut by a 20-lb. weight suspended in a pail of water at the bottom of the shaft.

The wires were shifted laterally until the vertical hair exactly bisected the plumb-string fore-sight and both plumb-wires. When this condition was reached, a transit set up in the tunnel below (as close to the wires as practicable) was shifted laterally until its vertical hair exactly bisected both wires. Then reversing, it threw the line forward, setting two or more plummet-lamps hung from verniers reading on graduated brass scales attached to the roof of the tunnel. Resetting on the wires, another set of readings was taken. Two more sets were taken in like manner with telescope reversed. The wires were then shifted and reset by the upper transit, and the previous operations were repeated for four more sets.

The whole of the foregoing operations was then repeated, after interchanging

transits at top and bottom, turning the water pails containing the weights partly around, shifting the wires, examining them to see that they hung free, and interchanging the members of the party. This work of plumbing the lines down the shaft was usually done on Sundays, when the cages were not running.

The base between the wires was about 10 ft. at the Manhattan shaft and 15 ft. at the Brooklyn shafts, and in each case was as long as permitted by the width of the shaft. On account of the shorter base in Manhattan, and the extra operation there in transferring line, opportunity was taken, when the headings were afterward extended west from the shaft, to check the line by plumbing through a vertical 6-in. pipe sunk from the surface to the tunnel at a point on the center line of one of the tubes, about 130 ft. from the shaft.

The alignment scales were brass bars, 1 in. wide, ¼ in. thick, and 10 in. long, graduated to 0.01 ft. They were connected by three flat iron bars to the bolts of the tunnel lining at the roof (Fig. 2). The scales were read to 0.002 ft. by a sliding vernier from which a plummet-lamp was suspended.

The line established on the scales near the shaft, as the mean result of many days' droppings, was produced by repeated runs read on scales set at intervals of about 200 ft. These runs were made by different observers, and using different transits, until mean readings were well established on the advance scales. Where the tube was on a curve, the scales were placed on tangents as long as could be obtained, and usually near points of intersection. The angles at these points were carried forward by repeated turnings on the forward scales.

When it became necessary to carry the line through a lock, the transit was placed on a trivet on a timber wedged across the lock at the forward end, where it had the support of the bulkhead wall. It was then lined in with the last two scales, the forward one having been located as close as practicable to the lock, and a reading was taken on a paper scale set inside the lock over the outboard door. The lock was then taken in, and, before throwing the line ahead, the paper scale was read again to detect any possible movement due to change in pressure. No trouble was ever experienced on this account, however, and when the bulkheads were advanced the lines thus locked through checked quite satisfactorily with lines carried through in free air.

To assist in aligning a transit with two given points, a very useful device was furnished by the instrument maker. This consisted of two sliding plates, which were attached between the transit base and the tripod head or trivet, and permitted considerable range of lateral movement by a slow-motion screw.

Giving Level Points for Grade

Grade was established between the two sides of the river as follows: Level runs were made from the shafts on each side to benches under the Brooklyn Bridge on the river side of each tower, at which point the river is much narrower than at the tunnel line. Levels were set up on each side, and simultaneous reciprocal readings were taken a number of times. The instruments were then interchanged and the readings repeated. In this way errors due to refraction, curvature, and imperfect adjustment were compensated.

Levels were transferred down shafts by reading on a tape hung in the shaft, and applying the required corrections. To guard against errors of method in using a tape in this way, a test was made by hanging the tape in the stair-well of a high building and comparing elevations obtained thus with those obtained by pegging up and down the stone steps with level and rod. Tunnel benches were generally located on lugs or cross-flanges near the lower quarter point of the tube.

General Conditions

Conditions for instrumental work in the tunnel were at times as good as could be desired, but at other times fog, powder smoke, and heat interfered seriously with the work. Much trouble was caused by scales being removed or disturbed, and, where this was likely to occur, they were boxed around. The zero points of scales were referenced to chisel cuts in the flanges of the lining. Where the tubes were in soft material, with one considerably in advance, the passage of the second shield would disturb the scales in the other tube.

When the Brooklyn headings had progressed about 1000 ft. along the tangent, and part way around the curve to the foot of Joralemon St., caissons were sunk at this point and connected to the tops of the tubes to form new shafts. To locate the corners of each caisson and to guide it during sinking, an underground traverse, tying in the corners of the roof opening, provided for by special segments, was reproduced on the surface. On making the connection the instrumental work checked closely.

These shafts afforded an opportunity to check the survey work thus far run, directly from the surface, and this was done with very satisfactory results. As the headings advanced on either side of the river, cross-connections were made between the tubes at certain points, giving an opportunity to compare the alignment, levels, and measurements carried forward in one tube with those carried forward independently in the other. There were three of these connections: two in rock on the Manhattan side, and one in the rock reef on the Brooklyn side.

The north headings were the first to meet under the river, and this was in December, 1906. When the shields were still 90 ft. apart, a 6-in. pipe was driven from the Brooklyn to the Manhattan side, by jetting and jacking, and the lines and grades were checked through. The pipe was driven straight enough to afford a clear sight from end to end, and, although somewhat off center line, was almost perfectly level, so that readings for grade could be made through it. A transit set up at each end produced the line through the pipe to the two forward scales in each heading, by which means the two center lines were found to be exactly parallel and 0.13 ft. apart. Of this discrepancy, about one-fourth could be attributed to the discrepancy of 0.02 ft., before mentioned, between the triangulated and measured distance across the river. The grades checked through the pipe within 0.01 ft.

The south headings, which had been keeping some distance behind the corresponding north headings, met in March, 1907. As the south shields were approaching to a junction, it was possible to reference the center line of each heading to the joined and corrected center line of the north tube. This was effected by pushing rods of a measured length through grout holes in the south side of the north tube until they brought up against the shell of the south tube at points which were then located and measured to. In this way the center lines of the south headings were brought together with an error of only 0.01 ft.

The greater part of the instrumental work in the tunnel consisted of giving the contractor lines and grades for the guidance of the shields and rock headings, and for the erection of the cast-iron lining of the tubes. A profile of the center line, taken at the top on the flanges of the rings, was kept posted on a cross-section sheet in the contractor's office near the shaft, and a similar record was plotted for line. Where the lining was erected behind a shield, the transit and level were used directly for giving working lines and grades, and no simpler method could be devised that would answer the purpose, because it was found that the reaction of the shield jacks would disturb the lining for a considerable distance back.

Where the headings were in rock, working points were given by lining in with the eye the flames of two plummet-lamps, hung from the roof by chains of adjustable length, and set so as to indicate grade as well as line. These lamps were made of a short piece of iron pipe, capped at the bottom, reduced at the top for a wick, and provided with a bail. They were suspended from hooks screwed in roof plugs, timber caps, or wedges in calking recesses, with a piece of sash chain and an adjustable section made of two strips of brass, by which the length of suspension was varied.

Secondary Stresses in Bridges

This subject has been considered recently in papers presented before two engineering associations, and we have combined and condensed some of the information for the benefit of our readers.

Important Relations of Secondary Stresses

In a paper by A. Reichmann* on "Structural Steel Design," in the February number of the *Journal* of the Western Society of Engineers the subject of secondary stresses is dealt with as follows:

The future development of our bridges depends upon the careful consideration and elimination, as far as possible, of the secondary stresses. These stresses may be reduced by the selection of the proper section for the diagonals and their attachments to the chords.

In a through bridge the elongation of bottom chord produces an elongation in the bottom laterals, resulting in heavy secondary stresses in both the floor beams and laterals when they are attached to the stringers and intermediate points. In a deck bridge the top chord being in compression is reduced in length, while the bottom flange of the stringers is elongated more or less, for which reason the stringers should be provided with extension joints at the floor beams in order to avoid excessive secondary stresses.

To minimize the effect of secondary stresses in a truss, it is well to omit knee bracing and sway frames at intermediate panel points. The main posts should be made the full depth of the truss wherever possible; in other words, bracing to increase the efficiency of posts and the use of sub-struts, materially increases the secondary stresses. Floor beams should be made deep and centrally connected to the posts. In order to avoid chord stresses to be transmitted to stringers, their end connections should be made flexible. This can be done by using a wide gage of the outstanding leg of the angle connecting the stringer to the floor beam.

When a truss with subdivided panels is used, the unit stress of the floor-beam hangers should be very low so as to keep down their elongation, as the elongation of the hanger produces heavy secondary stresses in the chords to which it connects.

Aside from the make-up of the various members of a truss and their connections, a great deal depends upon the type of span. Secondary stresses are very materially increased or decreased according to whether the truss is single-intersection, multiple-intersection, or multiple-intersection with vertical posts or without vertical posts.

Another source of secondary stresses in a truss is due to the fact that the bottom laterals are, as a rule, attached to the bottom of the post quite a distance below the bottom chord, so that the chord stresses in the lateral system must travel through bending in the post into the bottom chord. Besides this defect, laterals are not generally run in centrally with the chord, thereby inducing uneven distribution of chord stresses.

Discussion—In the discussion upon this paper, Mr. Reichmann stated that the amount of secondary stresses (in percentage of the primary stresses) varies considerably for different structures. In a 150-ft. riveted Pratt truss 28 ft. deep, it was as high as 32% in the chords, 19% in diagonals and 33% in the posts. If this had been a pin-connected truss with continuous top chord, the average would have been only 10%. In a 130-ft. riveted Pratt truss 26 ft. deep, the percentage was from 6 to 22%. J. M. Johnson referred to a 373-ft. truss 70 ft. deep, for the new Ohio River bridge of the Kentucky & Indiana Terminal Ry., at Louisville (Engineering News, Feb. 22); this is of the double-intersection type with 33-ft. panels. Both he and Mr. Greiner concluded that these stresses were 10 to 11% of the primary stresses, and that they could be ignored safely in view of the unit stresses used. He thought that in a through riveted 150-ft. truss 30 ft. deep, the stresses would not be anything like as high as 20 to 25%, as indicated by Mr. Reichmann. In 160-ft. spans of the double intersection type, Andrews Allen said he found higher secondary stresses than those mentioned by Mr. Johnson, although he used very limber diagonals of built-up H-section; but he was able to keep the fiber stresses within 25% above the allowed unit stress. Mr. Allen stated his general views as follows:

"The fact of the matter is that no one knows just what the secondary stresses are. We can figure them on a theoretical basis and still we know that the result is not correct, because we know that the effect of the stiffness of the joints and of the floor is to reduce the deflection of the span. The bridge members come into equilibrium somewhere. We do not know how much the secondary stresses are, but they are always less than our theory would indicate. Then, a bridge that has high secondary stress is usually very stiff, for the reason that the joints are stiff; and if we attempt to relieve ourselves of secondary stresses we often do so at the expense of stiffness of the bridge. So it is a matter that has to be handled with judgment; and I think it is entirely allowable to permit higher values for secondary than for regular stresses, for they occur only at certain points, they are not continuous, and usually have a tendency to relieve themselves.

Tests of Secondary Stresses

One of the committees of the American Railway Engineering Association is investigating the matter of impact and secondary stresses, and is making tests by means of special instruments. In a progress report submitted by Professors C. L. Crandall and F. E. Turneaure, at the annual meeting of this association in Chicago, Mar. 19 to 21, the work is reviewed as follows:

Through the assistance of the mechanician's shop at the University of Wisconsin, we were able to develop and manufacture a special form of extensometer for use in measuring secondary stresses. An important requirement of such an instrument is freedom from friction of all moving parts and, in general, a high degree of sensitiveness, combined with stability and strength of framework, convenience of adjustment and manipulation.

An instrument was developed along the line of the extensometers used for impact tests,* but to secure sensitiveness the principal bearings were made of knife edges, and instead of using a pencil for securing a continuous record, a ray of light is allowed to pass through a minute perforation in a disk at the end of the long lever, and a path of this ray of light is photographed on a moving slip of sensitized paper.

The apparatus proved satisfactory in practical operation, and the method of obtaining the record was found to be very good indeed. The sensitized paper was developed in the field so that results could quickly be obtained. Four of these extensometers were made by the University of Wisconsin and were used by the committee on its tests. About three weeks were spent in the field and tests were made on the following bridges:

On the Chicago, Milwaukee & St. Paul Ry., a 160-ft. riveted span and a 176-ft. pin-connected span at Byron, Ill., a 104-ft. pony truss span at Rockton, Ill., in which eye-bars were used for the diagonal members, and a span of the same length at Brodhead, Wis., in which all members were riveted. On the Chicago & Northwestern Ry., a 182-ft. riveted truss, a 75-ft. deck-plate girder, and a through riveted lattice truss, all on the new belt line at Milwaukee.

Beggarly Salaries for Municipal Engineers are probably paid here and there in all countries. An example of the sort is recorded and commented on in "The Surveyor," of London, England, for Mar. 15, 1912, as follows:

Municipal engineers who are seeking professional advancement should not overlook the unique opportunity presented by the vacancy which exists in the office of inspector of nuisances and borough surveyor of Llanidloes. It is true that the combined salary is only £75 [$365] per annum, of which £65 is allocated to the former office, but this must not be taken as a measure of the responsibilities involved. A capable and qualified whole-time officer is required, and he must hold the certificate of the Royal Sanitary Institute, or of some other similar body. He must also be experienced both in sanitary work generally and in questions arising under the Housing and Town Planning Act. We cordially congratulate the council of the borough of Llanidloes on the modesty of their requirements, and we hope that they may obtain, at a salary of £10 per annum, a borough surveyor who will bring to the discharge of his duties a degree of skill which such remuneration fairly represents—and no more. When will some authorities learn that the employment of skilled professional advisers is a true economy, and that such officers can only be obtained by the offer of reasonable salaries.

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*Resident engineer, American Bridge Co., Chicago.

*Engineering News, June 20, 1907.

Interurban Railway Station at Wheaton, Ill.

With the increase in extent and importance of interurban electric-railway systems, and the growth of their traffic, there has been a marked development in the character of the structures used by these lines. Passenger and freight stations are being established in cities and towns, and stations or shelters of artistic design are taking the place of plainer and rougher structures at suburban and roadside stops. Examples of a variety of structures of this class were described in our issue of June 1, 1911, and we describe herewith a station of rather exceptional size and style for intermediate points on railways of this character.

The Aurora, Elgin & Chicago Ry. is a double-track, third-rail electric line of heavy traffic, extending from Chicago to Wheaton, Ill. (25 miles), and thence to Aurora and Elgin. The city of Wheaton is an important point on the line, providing a large Chicago suburban traffic as well as local traffic, and being the junction of the two lines to the other towns mentioned. Here also are located the offices and shops of the company. For some years an insignificant frame structure with very limited accommodations has done duty as a passenger station, but work is now in progress on the construction of a more imposing and convenient station building. It was at one time proposed to erect a building which would not only serve as a station, but would contain the general offices of the company. However, the company has since acquired a large brick building for office purposes, and the station now being built will be for the passenger service only, with offices for baggage service and for the division superintendent. Fig. 1 shows the general plan and the elevation of the track side of the station.

The station is on the south side of the tracks, on a narrow strip of ground between the railway and the street, and owing to the slope of the ground its street side is approached by a flight of steps giving access to a terrace at the level of the track platform. This terrace will be surrounded by an ornamental balustrade of cast concrete, forming one of the architectural features of the station. The track platform is 10 to 12 ft. wide, built of concrete reinforced by a layer of wire mesh; it is faced with a ⅜-in. steel plate 6 in. deep, anchored to the concrete by ⅝ in. bolts 30 in. apart. The distance from the face of the platform to the base of nearest rail is 2 ft. 3 in.

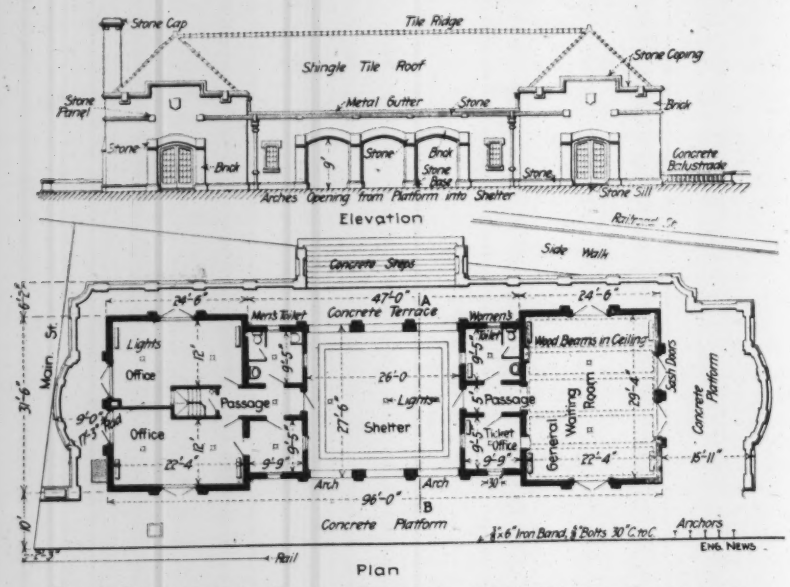


FIG. 1. ELEVATION AND PLAN OF NEW INTERURBAN RAILWAY STATION, AT WHEATON, ILL.; AURORA, ELGIN & CHICAGO RY.

The station consists essentially of two separate buildings under one roof, the space between them being a large covered shelter with arched openings on the street and track sides. Each building is 30 ft., and the distance between them is 26 ft., making a total length of 96 ft. One building will contain the general waiting room (22x29 ft.), ticket office and women's toilet room. In the other building will be two large offices and a smaller room, and also the men's toilet room. The two front offices will be for the use of the division superintendent, and probably the rear office will be devoted to the baggage and express service. A basement room is provided for the boiler of the steam-heating plant.

The exterior finish will be of rough-faced homespun brick (of a mottled greyish-buff color), with trimmings of Bedford stone. The floor will be of 4½-in. concrete, reinforced with ½-in. round rods 6 in. apart. This will be covered with quarry tile in the waiting room, mosaic in the ticket office and toilet rooms, and cement finish in the offices and shelter. The waiting room will have a brick wainscot (with 2-in. air space); the brick being the same as that used for the exterior; above this the walls will have a rough-cast plastered finish. Oak trim will be used in all the rooms. The waiting room will have a beam ceiling, and this room, as well as the offices, will have ceiling joists 2x12 in., spaced 16 in. apart. The lintels over the 5-ft. passages will be 5-in. I-beams, each with a plate ¼x10 in. The roof construction and the ceiling arrangement of the shelter are shown in the cross-section in Fig. 2. The rafters (2x10 in.) are 16 in. apart and are covered with ⅞-in. roof boards; over this sheathing is the outer covering of shingle tile. The general features of construction are shown clearly on the accompanying drawings.

One feature of the design which appears to be open to criticism is the arrangement of the ticket office; the track front of this office is set back 2 ft. from the front of the rest of the building and has only a small window. It is generally recognized as desirable that the station

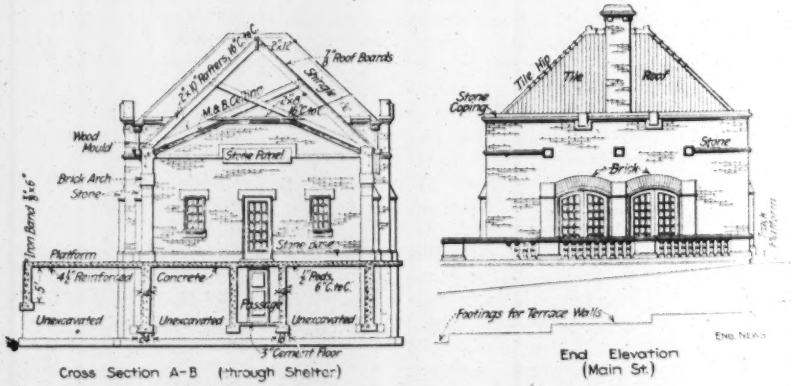


FIG. 2. CROSS-SECTION AND END ELEVATION OF INTERURBAN STATION, AT WHEATON, ILL.

agent should have a good view of the platform and track so that he can see the train movements and keep a general oversight. In the present building this is provided for by the very common arrangement of a bay window on the platform side of the office. In the new building, however, the range of view will be very limited, and will be restricted on the west side by the 2-ft. projection of the building. This is due apparently to subordinating the purpose or use of the structure to its architectural design, a practice which is not to be commended for buildings of this class at least.

The architects for this station are Horatio R. Wilson & Co., of Chicago. The plans were prepared under the general supervision of the railway company; Edwin C. Faber, general manager, and Charles J. Jones, chief engineer, at Wheaton, Ill. The cost of the building will be about $18,000.

The Uses of the Great Lakes*

By R. R. McCormick†

The reason for my being here tonight is to bring out discussion so that we may come to a national conclusion upon the national uses of the Great Lakes. The principle which is interesting in Chicago today, in future generations will probably go to many other communities which at the present time do not realize the importance of it. Law is being made, public opinion is being made.

The law of flowing streams is pretty well known to all lawyers and probably to most engineers. It is known that the law came, of course, from England, the common law of England, the small island, the place of little rivers. To stretch the theory of the rights of the riparian owner on such a stream as the River Thames or the River Dee to apply to the Great Lakes system, is not a proper interpretation of the common law. It is wrong.

I am glad to say that it has not yet been established in regard to the Great Lakes, but powerful interests, backed up by strong legal talent, are dinning it into the ears of the passer-by and are forcing it upon government officials, are forcing it upon the courts. It is incumbent upon the general public to stand up and maintain this point, that the Great Lakes are natural phenomena unknown to the English common law, utterly apart from it. Just as the feudal system has been refused recognition in the state of Michigan, so the theory of the little English inland streams must be refused recognition in the system of the Great Lakes.

Professor Williams‡ referred to the amount of power to be developed from the fall of the Great Lakes. We have come to an age where electrical power is transmitted easily a hundred miles. In many instances electrical power is transmitted over 200 miles. I will not venture to say what is the longest electrical transmission in existence, but I have no hesitation in saying that those of us who are not taken away by unexpected death will live to see electrical power transmitted 1000 miles; and when that time comes the electrical businesses will of necessity and by natural evolution combine into one corporation.

The question of regulation of 14,000,000 hp., state, interstate, and international, is a subject which must not be left to wait until the nation-wide corporation has been formed. Our Canadian neighbors have met the electrical power proposition. At Niagara, through a hydraulic electric commission—they have their own transmission line—they regulate the price of power so that the producer gets a reasonable income and the consumer gets the power at a price so cheap that nobody in Chicago could believe the figures, were they quoted. Electric power can be obtained in the province of Ontario for less than $15 a horsepower, 24 hours a day, 365 days a year. I can remember when the Sanitary District made a price of power of $36 a horsepower, that we hesitated and hesitated for fear that the price we made was unreasonably low. The price of power in Chicago, speaking on the horsepower basis, averages considerably above $100 per horsepower per year.

In the State of Illinois, as we all know, we have been trying for a number of years to build a short stretch of waterway at a small cost and we have not got anywhere. Why haven't we gotten anywhere? The answer is this: There have been in this controversy, two schools of thought. There has been the original school of thought of special privilege. There has been the new school of thought of the right of the government to continuously look after the rights of its citizens. The school of special privilege has its headquarters in St. Louis. Its theory of a development of a waterway is this: Government appropriations in large sums; the dockage to belong to the far-sighted man who combines business with politics and gets the practical sites in the beginning or has them already; the water power to be created, the natural increment to the riparian owners. Plausible warping of facts, plausible warping of the rights of man, plausible warping of the law, the claw inside the kid glove. That point of view is not questioned in the first report of government engineers, which provided for a 14-ft. waterway, and specifically said, "This waterway is developed so as to give the least inconvenience to the water-power owners along its course," omitting to mention the apparently insignificant fact that the expenditure of public funds was to create the water power that was to be.

The other school has begun from the other direction on the theory that every dollar of property created by public taxation should belong to the body which created it. While the battle is still very much in abeyance and the end is not yet, our side is still ahead. We have the biggest water power, with the biggest head of water—the drainage-canal water power at Lockport. They have two smaller powers, one in Joliet and one in Marseilles. They have the advantage, of course, that all the money they make is upon the investment of the public. The controversy from the point of view of water power exists in the northern end of our Illinois River and the Des Plaines River. The controversy in regard to the ownership of the dock sites whose value is entirely created by public funds is down at East St. Louis. The end is not yet.

What value is this war on railroads, this red flag which was painted by a man now dead and is waved in the faces of all of us to create waterways, water competition, to be created by public taxation and maintained by public taxation, if each landing stage is to be in the hands of a monopoly with a real estate value for the purpose of earning interest and the purpose of being taken over by the government as a harbor terminal to a waterway created at government expense?

We have three main uses for the Great Lakes. We have the use for water commerce, we have the use for water power, and we have the use for sanitation. At the present time the public mind outside of Chicago, and certainly in Washington, is not correct. It is wrong as to the facts; it is wrong as to the theory of the law, and it must be corrected. Navigation is not of particular value, water competition is not of particular value to the people, if the terminals are to be controlled either by the same people who control the railroads or by others who will charge exorbitant rates. The development of water power is not of particular value, either at Niagara Falls or at Lockport, or at Joliet, or at the Soo, or at Montreal, if it is going to be given to a few far-sighted people with interests in politics, who will resell it at a price which is just below the cost of steam production and make enormous profits out of a public stream in which no man can, under any correct theory of the law, have any private rights.

As to the sanitary needs, the other cities around the Great Lakes have no very adequate plans, such as those of Chicago, but when the sanitary needs are fully understood, they will come to very much more importance than the value of navigation or water power.

*Extract from an address before the Western Society of Engineers.

†President, Board of Trustees, Sanitary District of Chicago.

‡Engineering News, Dec. 14, 1911.

A Simple Automatic System for Lawn Sprinkling, Los Angeles, Calif.

By Burt A. Heinly*

Due to the semi-tropical and arid climatic conditions of southern California, the irrigation of lawns is necessary throughout the twelve months of the year. The Los Angeles City Park Department, after a close investigation and tabulation of the data obtained from different parks in all parts of the city, discovered that the maintenance expense, of which lawn sprinkling was the principal item, was practically eating up the annual appropriation and that nothing was left for improvements. Cheaper irrigation was the problem. This the department, after considerable experiment, has accomplished by the installation of an automatic sprinkling apparatus which nearly does away with manual labor and by so doing reduces the cost of irrigation over 80%.

The system is simple in the extreme. It is composed (Figs. 1 and 2) of pipes laid in radiator circuits from 12 to 15 in. beneath the ground, which supply standpipes to which sprinkler heads placed flush with the ground are attached at intervals of 20 ft. Experiments showed that a circle whose diameter is the diagonal of a 20-ft. square is about the maximum over which water can be distributed from a single sprinkler top. It is obvious that to irrigate any large area simultaneously, the supply main and radiating pipes would have to be of large size, else the resultant release of water from many escapes would so reduce the pressure as to destroy the purpose of the apparatus. The radiator system is therefore separated into circuits or series, each of which is controlled by one or two valves, according to whether the circuit is fed from one or two ends. With the application of a volume of water equal to the discharge, the series is set in operation, the sprinkler then providing the necessary distribution in the form of a spray.

The system was devised by Frank Shearer, superintendent of parks, and the installation was made in Central Square (Fig. 2), a five-acre tract near the heart of the retail shopping district. The park was being entirely remodeled, which included the stripping of the lawn, so that unusual opportunity was offered for the work. Here a single-feed system, controlled by one valve (Fig. 1) was used. The supply main is 4 in. in diameter and the circuit pipes 2 in. in diameter. The water pressure in the city mains is approximately 60 lb. per sq.in. at this point. It was found that the Wilgus sprinkler heads worked most satisfactorily under this pressure. Three dozen of these were attached to each series, which irrigates approximately 17,000 sq.ft. Eleven series are thus required for sprinkling the 4.3 acres of lawn area. The system cost about $400 per acre, installed, which is nearly double the cost of piping for hose irrigation, which includes the purchase of hose.

With this system in use, it requires the time of one man for only two hours to do the day's sprinkling over the entire park. With irrigation by hose sprinkling it took two men the entire day to perform the task. At the rate of $2 per day for eight hours' work, this is a net daily saving of $3.50 per day, or $1277.50 per year on this small park, where within 20 months the device will pay for itself.

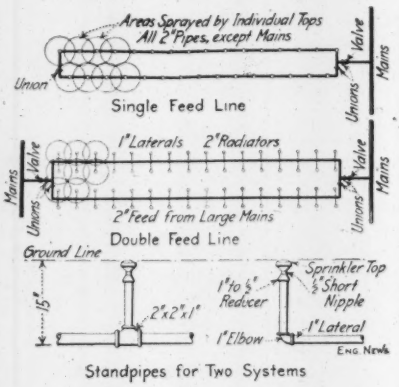


FIG. 1. SPRAY IRRIGATION SYSTEM, LOS ANGELES, CALIF.

In the experiments that were carried on, it was found that the system is not practicable where the water pressure is less than 30 lb.; also, that liberal provision should be made to prevent the overloading of the distributing main with its laterals. In tests of a number of sprinklers the Wilgus proved the best for a pressure of from 60 to 70 lb.; the Hadden, from 50 to 60 lb.; the Thompson, from 40 to 50 lb., and the Hennessy from 30 to 40 lb.

The Wilgus top, which has practically been adopted by the Los Angeles Park Department for the large amount of work it has under way, is of local manufacture and was originally designed by the Wilgus Manufacturing Co. (Boyd St., Los Angeles, Calif.) as a sprayer to be used in a crude-oil burner. When Mr. Shearer first began his experiments there were no water sprayers on the market at all adapted to his purpose. The Wilgus crude-oil sprayer theoretically seemed to meet the requirements best. This was borne out by the results.

In the Wilgus sprinkler the water rises in the pipe and strikes the horizontal wall of the sprinkler (Fig. 3) which diverts the flow. When the water passes through the tyo ports it acquires a whirling movement similar to the activity set up by the runner of a centrifugal pump (Fig. 2). As it reaches the outer orifice, the whirling volume of water is released, which gives a distribution in fresh air of approximately 12 to 15 ft. radius for a ½-in. sprinkler top under a pressure of from 50 to 60 lb.

Some other sprinklers on the market are modifications of the Wilgus, but are molded and put together instead of being cast. While this gives a more perfect mechanical adjustment, they are more likely to breakage from mower and rake.

FIG. 2. SPRINKLING A 5-ACRE PARK IN 30 MINUTES, LOS ANGELES, CALIF.

It is the experience of the Park Department that the Wilgus gives the best satisfaction for its class of work. Only about 10 per cent. have casting flaws and the makers cheerfully replace these in addition to guaranteeing the tops for ten years. Jobbers give a catalog retail price of $9 per dozen and this is materially reduced by purchase in considerable quantity.

*636 South Hill St., Los Angeles, Calif.

So successful has been this simple system of sprinkling that it is now being installed at Los Angeles Exposition Park, where 45 acres is to be devoted to lawn and shrubbery. Here the double-feed system (Fig. 1) will be installed at an estimated cost of $350 per acre. Two men, one at each end of the circuit, will be needed for this double-feed system.

The innovation in such a public place caused its wide advertisement throughout the city with the result that individuals sought to copy the improvement. Residence five-eighths connections, of course, failed to supply the requisite quantity of water for any number of sprinklers and some ill feeling was brought out when the city water department refused larger connections for the reason that by the general installation of the sprinklers, the peak load of the mains would be made excessively high.

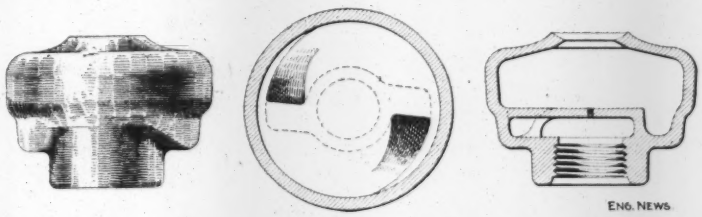


FIG. 3. DETAILS OF WILGUS SPRINKLER USED ON PARK LAWNS OF LOS ANGELES, CALIF.

It is possible, however, to install the system upon a small lawn where the entire area can be sprinkled in from 10 to 20 minutes, depending upon the pressure and whether the sprinklers are set in a single or double series. From the usual ⅝-in. domestic-service connection, six sprinkler tops on a ½-in. main will cover a front lawn having a breadth of 50 ft. and a depth of 30 ft., which are about the average dimensions of the lawns of middle-class householders of this city. It is better also to place them three to the series, with two feed valves. This will double the time required to sprinkle, but it will give better results. Instead of the Wilgus sprinkler, it is recommended that the Hennessy be used, for the reason that the tops of the latter are smaller and while they have the same area of distribution a less volume of water is required for their successful operation.

The Effects of Tars and Other Road-Dust Abating Substances on Fish Life

Tar and other road-dust preventives in relation to fish life in streams which receive road drainage was the subject of a long paper and extended discussion before the Institution of Municipal and County Engineers at London, England, on Feb. 9, 1912 (see *The Surveyor*, London, Feb. 16, 1912). The paper was by W. J. A. Butterfield, who first reviewed the various dust-abating materials and then recounted at length the results of experiments made by him to show the effect of solutions of ammonia and ammonia salts, coal-tar oils and their chief associated bodies, and also various solutions or extracts of fertilizers upon fish. Most of the experiments seem to have been with dace and gudgeon, but less detailed observations on the effect of ammonia were made on numerous other kinds of fish. The author's conclusions were as follows:

(1) That ammonia and many of its salts are very highly toxic to fish, and gas liquor is nearly as toxic as clean water containing the same proportion of free ammonia.

(2) That it follows that the use on roads of coal tar containing gas liquor (i.e., crude tar) is attended by appreciably greater risk of injury to fish life than is the use of coal tar which has been "freed" from gas liquor.

(3) That of the oils contained in coal tar the "light oils" are the most harmful to fish life, and since the light oils are to a large extent removed from coal tar by the procedure which is followed for the removal of gas liquor, an additional reason is afforded for preferring "freed" to crude coal tar.

(4) That the phenols are highly toxic to fish, though less so than ammonia.

(5) That tars in which phenols and allied bodies ("tar acids") are present in high proportion may render water which has been in intimate contact with the tar toxic to fish in degree approximately corresponding with the amount of phenoloid bodies acquired by the water from the tar.

(6) That, other things being equal, water acquires a smaller proportion of phenoloid bodies from a thick, highly viscous tar than from a thin, freely fluid tar.

(7) That, taking into consideration (5) and (6), and the fact that light, thin coal tars generally contain a larger proportion of tar acids than heavy, thick coal tars, the use on roads of light, thin coal tars is attended by appreciably greater risk of injury to fish life than the use of heavy, thick coal tars.

(8) That the risk of injury to fish life from the use of "freed" coal tar on roads is negligible, provided the tar contains less than 3% by volume of crude tar acids, and the area of the tarred surface is not greater than one-twentieth of the total area of ground draining into a watercourse.

(9) That naphthalene and coal-tar pitch are not distinctly harmful to fish life.

(10) That the use on roads of a "freed" carburetted water-gas tar is attended by less risk of injury to fish life than the use of a "freed" coal tar. (The use of "crude" carburetted water-gas tar is, however, inadmissible, owing to the large proportion of light oil in it.)

(11) That the use on roads of blast-furnace tar, or of preparations containing much blast-furnace creosote, is attended by considerably greater risk of injury to fish life than the use of a "freed" coal tar.

(12) That some important natural asphalts and asphaltums and petroleum preparations are not distinctly harmful to fish life.

(13) That the use of salt water, or of calcium chloride for dust abating is not attended with risk of injury to fish life.

(14) That there is a remote risk of injury to fish life from washings from accumulations of horse droppings or stable manure, and that the use of sulphate of ammonia as a fertilizer is attended by appreciably greater risk of injury to fish life than the use of nitrate of soda. All the risks referred to in this paragraph are, however, in all ordinary circumstances so remote that they are negligible.

The surveyor may, in the author's opinion, safeguard himself in the use of tar on roads in all ordinary cases if he uses only coal tar or a mixture of coal tar and carburetted water-gas tar, which, in either case: (1) Is of not lower specific gravity at 15° C. than 1.18; (2) contains not more than 1% of water or gas liquor, the ammonia in which is equal to not more than 5 grains per [Imp.] gallon of tar; (3) contains not more than -% of light oils; and (4) contains not more than 3% by volume of crude tar acids.

If cases occur where the washings from tarred roads will not be diluted to at least twenty times their volume before, or immediately on, entry to fishing waters, the maximum limit of water or liquor in the tar should be reduced to 0.2% of ammonia to 1 grain per [Imp.] gallon of tar, and of light oils to 0.8% (or 1% of distilaite below 170° C., inclusive of water). As an extreme precaution in certain cases a tar prepared from pitch and "dead" tar oils (i.e., middle and heavy, tar oils from which the phenols have been extracted) might be used, and when the market value of carbolic acid, etc., is high, the cost of such a prepared tar should not be very much greater than that of an ordinary good "freed" coal tar.

In the discussion following the paper one speaker suggested that fish in a stream can often get away from what is disagreeable or dangerous, but that in the experiments they could not escape.

That there was excuse if not warrant for a study of the subject under discussion was indicated by a statement from Col. R. Crompton, of the British Road Board, although he evidently thought it was largely a case of scare. Colonel Crompton said:

He was in the position of suffering from this fish scare perhaps more than any other person in the country. It almost meant an extra clerk in his office to attend to correspondence calling upon him to say something authoritative to contradict the scare the fishermen had got that tarred roads were going to destroy fisheries all over the country. He really thought that the number of fish actually killed was so exceedingly small that he doubted whether they had been killed by tar at all. Really, the evidence that there had been any change in the number of dead fish found was so extremely small that it was not going

too far to say that it was very exceptional that fish had ever been killed by tar. Of course, keen fishermen thought otherwise.

T. Milne, of the Gas Light & Coke Co., remarked that such danger to fish as exists comes from the ammoniacal liquor in crude tar. If water-freed tar, of a gravity not less than 1.2, were used there would be no trouble.

If we mistake not, little except refined tars are used for road purposes in this country; which, combined with the relatively large volume of most of our streams, would seem to warrant the idea that engineers in the United States need not worry much over the subject in question. It is well, however, to keep posted on this subject, as well as on the possible dangers of road tarring to vegetation near roads (see portion of article on "Surface Tarring of Macadamized Highways," by Dr. Guglielminetti, in our issue of Sept. 7, 1911, p. 285).

Electric Traction Developments in London

An important improvement of the rapid-transit facilities of London, affecting both urban and suburban service, is to be made by and in connection with the London & Northwestern Ry. It will comprise three features: (1) paralleling the main line with tracks for suburban electric service, (2) connecting these electric tracks with an underground electric railway crossing the city, and (3) converting some of the urban and suburban lines to electric traction. The accompanying map shows the general situation.

In view of the congestion of traffic on the main line and the growth of the suburban traffic (which also has to be handled on this line), the London & Northwestern Ry. obtained authority (in 1907) to build beneath its existing right-of-way a deep-level underground electric railway from Willesden Junction to the great terminal station in Euston Square, where a separate underground station for suburban service was to be built, giving easy access to the stations of existing underground urban lines. Beyond Willesden, the line is in open country and additional surface tracks can be built to the present end of the suburban service, at Watford.

But Euston Station is not an originating or terminating point for suburban traffic, and 90% of these passengers have to use other lines to go to and from that station. It has been decided, therefore, to extend the surface widening from Willesden Junction eastward to Chalk Farm, where there is a connection with the North London Ry. (owned by the L. & N. W. Ry.). Then there will be six tracks from Willesden Junction to Chalk Farm, two of which will be for electric traction; and two of the four tracks of the North London Ry. will be equipped for electric traction, so that the electric suburban trains can be run through from Watford to Broad St. Station (near the heart of the city). Some of the tracks between Chalk Farm and Euston will be equipped also for electric traction.

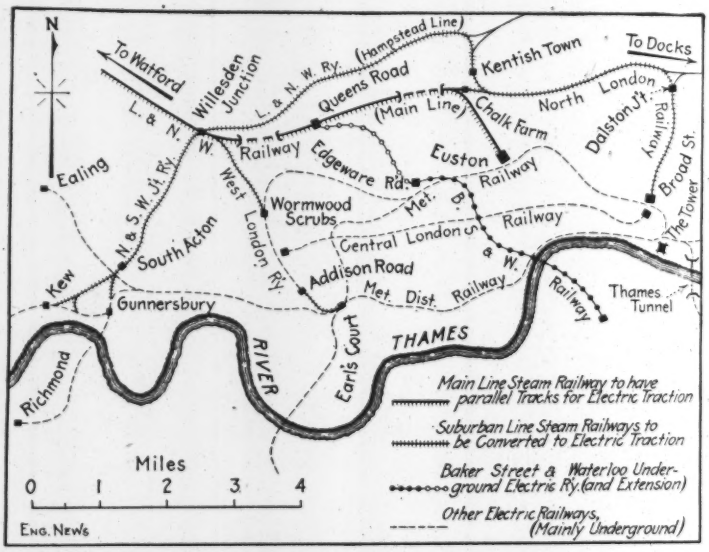
To increase the facilities still further, it is proposed to extend the Baker St. & Waterloo Ry. (one of the underground electric "tube" lines) from its Edgeware Road terminal to a connection with the electric tracks of the London & Northwestern Ry. at Queens Road. If this is carried out it will be the first case of operating through trains from main lines into the "tube" system. Practically all the numerous tubes are of such small diameter as to preclude such interchange of rolling stock. This does not apply to the old underground lines of the Metropolitan Ry. and Metropolitan District Ry., which are large double-track tunnels (built originally for steam service) and which are close to the surface, as distinguished from the deep-level "tubes." The Great Northern & City Ry. has its tubes of sufficiently large section to admit main-line cars, the intention having been to connect with the Great Northern Ry. at Finsbury Park and run some of the suburban trains of the latter over the tube line instead of into the main-line terminal at Kings Cross. This plan, however, has never been carried out, and there is no track connection between this tunnel line and the surface main line.

The third feature mentioned above is the electrification of certain lines subsidiary to the London & Northwestern Ry. In addition to the North London Ry. (noted already) the Hampstead line of the L. & N. W. Ry. and its connection with the North & South Western Junction Ry. (see map) will be electrified from the connection with the N. L. Ry. at Kentish Town to Willesden Junction, Acton and Kew; the branch to Gunnersbury also will be electrified, giving connection with an existing electric line to Richmond. Further, the West London Ry. will be electrified from Willesden Junction to Wormwood Scrubs, and from Addison Road to Earls Court, thus completing connections with other existing underground electric-railway systems.

With these important works completed, the London & Northwestern Ry. will have direct communication with very important suburban and outlying districts, and also it will have three routes into the busiest portions of the city, over its own lines to Euston and Broad St. and over the line of the Baker St. & Waterloo Ry.

Another important project in the extension of electric traction is the electrification of the East London Ry., which passes through the old Thames Tunnel (built by Brunel) and has a local service connecting points on the north and south sides of the river Thames. The line is 5¼ miles long, and through trains of the Metropolitan underground lines were operated over it until these lines adopted electric traction. In nine years from the abandonment of this service the passenger traffic decreased 60%. The electrification is considered necessary therefore to regain traffic by renewing the through service, while the growth of electrically operated lines on both sides of the river offers opportunities for additional extension of through service.

It may be added that the extensive studies reviewed indicate that if tarring roadways presents any material danger to vegetation, it is confined to ornamental plants close by the roads.



MAP SHOWING NEW SURFACE AND UNDERGROUND ELECTRIC LINES AT LONDON, IN THE INTERESTS OF THE LONDON & NORTHWESTERN RY.

Condensed Report of the Water Works of Battle Creek, Mich., for 1911

If a prize were to be offered for the best combination of brevity and information in the way of an annual water-works report we think it would go to W. W. Brigden, superintendent and civil engineer of the water-works of Battle Creek, Mich., for his long series of condensed reports.

Mr. Brigden's condensed report for the year 1911 fills two pages, the printed portion of which measure 7x10 in. each. Most of the information is statistical. The works were built by the board of public works in 1887 and have been operated by the board ever since.

With the exception of a meter table, summarized at the close of the article, the report is as follows:

Source of supply, Goguac Lake, 360 acres area; water shed, 1½ sq. miles; maximum depth, 80 ft.; surface of water over 80 ft. above business part of city. Part of the year the lake is fed from Minges Brook; drainage area, 14 sq. miles. Two Blake compound, duplex, condensing steam pumps, each 2,500,000 gal. daily capacity, and one Union Steam Pump Co. crank and flywheel Corliss steam pump, 3,000,000-gal. capacity. Pressure, 65 to 85 lb. downtown, 45 lb. at pumps. Average lift of pumps, 120 ft., including suction and friction. Standpipe, 75x18 ft., top 200 ft. above business part of city; located on highest ground near the city; capacity, 143,000 gal. Bonded debt, $30,000; no other indebtedness. We pay all operating expenditures, interest and construction work out of net earnings, and could pay the $30,000 bonds, payable in 1915-16-17, if they were due. Balance in hands of city treasurer to credit of water fund, $34,600, so we practically owe nothing.

We operated our water-works for over 21 years without purchasing a new pump, boiler or other similar part of the plant. We have made no extraordinary construction expenditure except $23,000 for diverting the Minges Brook into Goguac Lake for a larger supply, as contemplated before the works were built, and about $12,000 for a large number of experimental wells. In 1909-10 there were added a new 12-in. force main, inlet and suction pipes, extension to pumping station, a 3,000,000-gal. pump and a 12-in. main to the southeast portion of the city.

WHERE CITY WATER GOES

665,000,000 Gal. Pumped During 1911

How used or wasted	Per cent. of water pumped	Value at 10c. per 1000 gal.
Paid for by meter, 478,000,000 gal. (Received over 11c. per 1000 gal. average price)	72	$47,880
Paid for, not metered	1	665
Parks, public buildings, etc., except schools	4	2,660
Schools, including lawns	3	1,995
Drinking fountains for horses and people	4	2,660
Flushing sewers	2	1,330
Blowing-off hydrants	1	665
Wetting down trenches, sewer, water, etc.	2	1,330
Fires	3	1,995
Slip of pumps	3	1,995
Under-registration of meters	2	1,330
Leaks, etc.	3	1,995
Total	100	$66,500

CONDENSED STATEMENT FOR THE YEARS 1908, 1909, 1910, 1911

	1908	1909	1910	1911
Total cost of construction to Dec. 31	$435,013.07	$463,437.47	$496,929.16	$53? 111.78
Expended for mains	15,866.02	15,254.71	25,640.94	2?,?27.98
Expended for service pipe to curb including 40 taps for paving)	3,654.33	3,910.25	4,353.35	4,777.90
Average cost of service, main to curb	11.25	10.65	10.20	10.81
Length of mains, miles	51.8	54.5	58	62
Street valves	440	463	490	524
Public hydrants	534	556	586	623
Number meters in use	4,115	4,480	4,881	5,318
Per cent. of taps metered	93	94	95	96
Per cent of water metered and paid for	66	60	57	72
Number of services, not including taps on account of paving	4,406	4,728	5,114	5,516
Number of park fountains, public	5	5	5	5
Public drinking fountains for horses	8	8	8	8
Public drinking fountains for people	7	7	7	7
Operating expenses	$16,351.88	$14,955.22	$17,590.87	$18,006.62
Expense charged pumping account	7,801.14	7,518.05	8,833.96	8,517.76
Cost of coal used	3,032.92	3,156.96	3,422.15	2,919.85
Water pumped, in millions of gal.	620	688	762	665
Average water pumped per day, gal.	1,700,000	1,885,000	2,087,671	1,823,309
Largest day's pumping, gallons	3,468,647	3,483,405	4,420,360	3,943,262
Smallest day's pumping, gallons	978,445	1,307,070	997,575	998,468
Average cost per 1000 gal. for coal, cents	.49	.46	.45	.44
Average cost per 1000 gal. for pumping expenses, cents	1.3	1.1	1.2	1.3
Average cost per 1000 gal. for total operating expenses, cents	2.6	2.2	2.3	2.7
Average cost per 1000 gal. for operating expenses and interest at 4% on total cost, cents	5.4	4.9	4.9	5.9
Average cost per 1000 gal. for operating expenses, interest and depreciation at 3%	.....	.....	.....	8.3
Estimated population of city	24,000	25,000	26,000	27,000
Water used per day, per capita, gal.	78	75	80	67
Water used per day, per tap, gal.	385	400	408	330
Level of water in lake below gage, Dec. 31, feet	11.1	8.9	9.8	8.7
Rainfall, inches	30.03	39.12	29.84	46.85
Average annual rainfall in this locality, inches	.....	.....	.....	30
Receipts for water, including advance on application	$45,124.08	$46,023.61	$49,194.48	$53,720.88
Receipts per tap on total number	10.24	9.73	9.62	9.74
Average receipts per 1000 gal for metered water, cents	10.7	11.0	11.2	11.2
Average receipts per 1000 gal. for all water pumped, cents	7.3	6.7	6.5	8.1
Receipts for licenses	$22.08	$25.02	$33.13	$30.00
Duty—Total coal used (foot-pounds per 100 lb. of coal	40,000,000	40,000,000	42,000,000	36,000,000

All the above uses are free except the first two. If water-works officials will compare their results with those above given and discuss the same it will no doubt result in good to all. It is not claimed that the figures are close ones. Very few such figures in detail have been made public.

Per cent of service metered	96
Per cent. of water metered	72

REVIEW OF FINANCIAL RESULTS OF OPERATING FOR 1911

Income from water rates		$53,720.88
Income from rent of meters		5,902.15
Proper charge for use of 623 hydrants	$40.00	24,920.00
Proper charge for city hall, engine houses, schools, water troughs, parks, flushing sewers, etc.		6,000.00
Total		$90,543.03
Operating expenses	$18,006.62	
Interest on total cost at 4%	21,324.47	
		39,331.09
		$51,211.94
Estimated depreciation, 3% on total cost		15,993.35
Net gain by operating		$35,218.59

Meter rates, 6 to 13c. per 1000 gal. Minimum annual rate, $3, except for large pipes, which are as follows: 8-in., $400; 6-in., $200; 4-in., $100; 3-in., $75; 2-in., $50; 1½-in., $35; 1¼-in., $15; 1-in., $6. Sprinkler-system pipes for fire protection, $25 per year, and double regular meter rates for water used or wasted through sprinkler meter, or outside same.

Meters are sold at cost or rented at annual charge of 10% on cost, except ⅝-in. meters rent for 10c. and ¾-in. for 12c. per month.

All new takers must put on meters, and all who change pipes or fixtures or add thereto.

We began placing meters in time, did it gradually, and made it an object by giving low meter rates, so we had no real trouble. Our people approve of a meter system almost unanimously.

WATER MAINS, DEC. 31, 1911

Size, in.	Length, ft.	Per cent.
4	14,870	4½
6	183,083	56
8	84,153	25¾
10	1,062	⅓
12	32,828	10
16	11,757	3½
Total	327,753	100

The meter table shows that on Dec. 31, 1912, there were 5318 meters in use, of which 4929, or all but 389, were rented to consumers. There were sixteen different kinds of meters in use. The ⅝-in. meters numbered 4302, and the ¾-in. numbered 918.

Sanding of Wood Block Pavements is extensively carried on in the city of St. Louis, where each year about 70,000 sq.yd. of this pavement is treated with a sprinkling of oil and sand. The oil used is a residuum oil of 16 deg. Bé., and it is spread by a machine designed for the purpose and followed immediately by hand spreading of sand. This treatment costs about 2c. a sq.yd., and is made in the fall of each year. It is found that in most streets the treatment furnishes sufficient surface to last until the succeeding fall, although in some few cases where the grade is high and the traffic heavy, subsequent treatments are found necessary. The sand and oil makes a rough surface, which effectually reduces the common slipperiness of the wood-block pavement.

Tests of Vacuum Cleaner Apparatus*

By M. S. Cooley†

Tests of vacuum-cleaning tools were made which led to the conclusion that the width of cleaning slot should be not less than ½ in. and the length of slot not less than 12 in.

The most suitable diameter of hose was 1½ in. and in pipe-line cleaner installations in buildings, the pipe diameter should be not less than 2½ in. with a steady vacuum of 6 or 7 in. at the pump.

Comparative data are given on the performance of different types of vacuum-cleaner pumps and a method of acceptance test for cleaner systems is suggested.

*Abstract of a paper read before the American Society of Heating and Ventilating Engineers.

†Supervising Architect's Office, Treasury Department, Washington, D. C.

The tests described below were made by the author three years ago and were primarily to determine (1) the feasibility of using a carpet-cleaning test to determine the merits of a vacuum-cleaning system; (2) to fix the requirements to be incorporated in a specification where acceptance of the system was dependent on a satisfactory cleaning test; (3) to determine what requirements, rather than a cleaning test, would be necessary to obtain a first-class cleaning system.

In making carpet-cleaning tests, three types of carpet renovators were used which the author has referred to as types *A*, *B* and *C*, in the order in which tests were made. Sections of these renovators are shown in Fig. 1.

Type *A* renovator has a cleaning slot ⅛ in. wide and 12 in. long in communication with a second slot which is open to the atmosphere through an opening under a dividing partition as shown in the figure. The partition stands ½ in. above the working face of the tool. Type *B* has a cleaning slot ⅛ in. wide and 12 in. long, with no opening for admission of air other than the cleaning slot. Type *C* has a cleaning slot ¼ in. wide and 10 in. long, with no other opening for admission of air.

A number of preliminary tests were made with the object of obtaining some substance, with which carpet could be artificially soiled, which would be as difficult to remove as dirt ground in by usage. As a basis for comparison, a test was first made on a glue-sized Brussels carpet which had been in use for many years. This was divided into three parts, measuring approximately 7 sq.yd. each and each containing, as was subsequently discovered, about 12 oz. of dirt. Each piece of carpet was cleaned during six periods of one minute each, using a different vacuum at the tool handle for each carpet. The carpets were weighed at the beginning of the test and after each one-minute period. At the conclusion of these tests each carpet was cleaned until no change in weight occurred after two minutes' cleaning. They were then considered 100% clean, and this standard was used as a basis for computing the per cent. of dirt removal given in Table I. The air consumption was computed from indicator cards taken from the vacuum pump during each test.

TABLE I. DUST REMOVAL TEST WITH TOOL A

Vacuum in handle, in. hg..	1	2½	4
Cu.ft. air per min.....	30	43	50
Per cent. dirt removed:			
In one min.....	37	39	47
In three min.....	59	66	71
In six min.....	67	82	90

A number of substances for artificially soiling the carpets were tried, including wheat flour, portland cement and molders' sand. No material was found that was nearly so hard to remove as the dirt from a carpet soiled by usage. Finally dry sharp builders' sand, screened through a 50-mesh screen, was tried and found to be the most satisfactory. The results of tests made with this material are summarized in Table II.

TABLE II. SAND REMOVAL TEST: TOOL A

Vacuum at handle, in. hg.	1	2½	4
Cu.ft. air per min.....	30	43	50
Per cent. sand removed:			
In one min.....	45	61	50
In three min.....	73½	84	77
In five min.....	..	94½	97

When carpets were artificially soiled, the manner of making the tests was as follows: A carpet of known area was cleaned until no change in weight occurred in two minutes' cleaning and then weighed to the nearest quarter ounce. The screened sand was then weighed and sprinkled on the carpet and worked in with the feet until none of it could be seen on the surface of the carpet. It was found by experiment that no measureable loss of material occurred in working it in.

Similar tests with dry sharp sand were made on the same carpets as before, using type *B* renovator, with the result given in Table III.

TABLE III. SAND REMOVAL TEST TOOL B

Vacuum at handle, in. hg....	2	4	4½
Cu.ft. air per min.....	24½	35	39½
Per cent. sand removed:			
In one min.....	48	54	[illegible]
In three min.....	91	100	[illegible]
In four min.....	100		

Shortly afterward the author was afforded the opportunity to test a renovator of type *C*. The exhauster available, however, would not produce a vacuum of more than 6 in. of mercury, and this vacuum could not be readily controlled. These tests therefore were made with 3½-in. vacuum at the tool handle. The tests were run on a dirty carpet of 4-sq.yd area containing about 6 oz. of dust, and also on carpet filled with sand. The results are given in Table IV.

TABLE IV. TESTS WITH TOOL C

	Dirt Test	Sand Test
Vacuum at handle.....	3½	3½
Cu.ft. air per min.....	66	66
Per cent. dirt or sand removed:		
In one min.....	40	68
In two min.....	60	82
In three min.....	90	100

Taking the results from all these tests with a vacuum at the tool handle of from 3½ to 4½ in., the number of cubic feet of air required to remove 1 oz. of sand with the three types of renovators is as follows: Type *A*, 50 cu.ft.; type *B*, 17 cu.ft.; type *C*, 22 cu.ft. This is with carpet containing approximately 1 oz. of sand per sy.yd. of carpet, which was the maximum that could be rubbed into the carpet used in the first test. Judging from tests on dirty carpet, this is approximately 80% of the amount of dirt ordinarily to be found in a very dirty carpet.

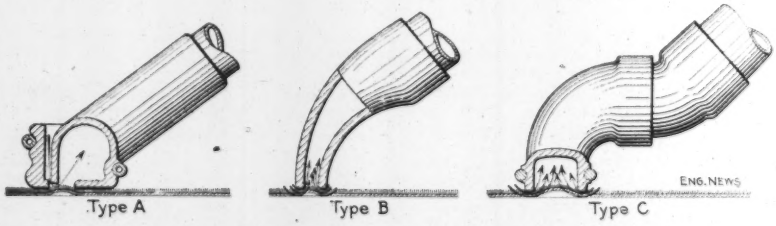


FIG. 1. SECTIONAL VIEWS OF THE THREE TYPES OF CLEANING TOOLS TESTED

An analysis of the tests shows that in order to clean the carpet effectively, we must have some degree of vacuum under the tool itself. Merely a current of air is not all that is required. For example, in the case of type *A* renovator, with 30 cu.ft. of air passing and 1 in. of vacuum under the renovator, but 76% of the sand was removed in four minutes. With type *B* renovator, with 24½ cu.ft. of air passing and 2 in. of vacuum under the tool, 100% of the sand was removed in the

same time. On dirty carpets the result is even more marked. Apparently when working on a dirty carpet, it is the vacuum that loosens the dust from the carpet, the air acting as the conveying medium for removing the dirt loosened by the vacuum.

For a rapid, thorough and effective cleaning of carpets and other fabrics of equal weight and thickness, the author considers that a vacuum of at least 3½ in. at the tool handle is necessary. It is evident, however, from tests made of the effort required to move vacuum-cleaning tools over the floor with various vacuums at the tool handle, that a vacuum very much higher than 4 in. or 5 in. will cause the tool to stick and be hard to operate, and will be likely to cause undue wear on the carpet.

Comparing the efficiency of these renovators as dust removers, type *B* is more efficient than type *C* and both are vastly more efficient than type *A*. This can be accounted for by the construction of type *A* renovator, which receives the bulk of its air under the partition between the cleaning and the inrush slot, while both of the other types receive air under both sides of the cleaning slot as indicated by the arrows in Fig. 1. In actual carpet cleaning, however, we have to pick up and move not only dust, but matches, bits of paper, and other litter which are obviously too large to pass the narrow slot of type *B* renovator. Therefore the ideal system would be one using type *C* renovator and arranged to maintain a constant vacuum of 3½ to 4 in. at the handle irrespective of the quantity of air passing.

Hose and Pipe-line Friction

In a complete system, the elements between the renovator and the vacuum producer which affect the control of the vacuum at the renovator are the hose, pipe line and dust separators. Fig. 2 shows the results of actual tests of the friction loss in cleaning hose of 1, 1¼, 1½ and 2 in. diameter. In all the tests of type *A* and *B* renovators, 100 ft. of 1-in. hose was used and a 15-in. vacuum was maintained at the hose cock. Under these conditions, the vacuum at the tool handle varied from 1 to 13 in., due to the variation in the quantity of air passing into the renovators when operated on various surfaces. The variation in vacuum was considerably less with type *A* renovator than with type *B*, due to the effect of the inrush slot which acts as a vacuum breaker when the renovator is operated on smooth surfaces or dense fabrics. This, however, is obtained only at a sacrifice in cleaning efficiency, as the leakage or bypass effect of the inrush slot is always present.

Much better results, moreover, can be obtained by using type *B* or *C* renovators connected with 1½-in. hose. In this way the total variation in vacuum, when operating on various kinds of surface, will not exceed 1 in. for type *B* renovator, nor 1½ in. for type *C*, without recourse to any type of vacuum breaker in the renovator or tool handle.

Pipe lines add their friction effect to that of the hose line, but in a far less marked degree, as they are seldom made less than 2 in. in diameter. With a system so designed that the maximum length of hose necessary will not exceed 75 ft., and with the 1½-in. diameter hose and ample sized pipe line, the maximum loss in vacuum between the tool handle and the vacuum producer will not exceed 3 in. In designing pipe lines, care must be exercised that the velocity in these lines never fall below 2500 ft. per min., otherwise dust will be deposited in the pipe line.

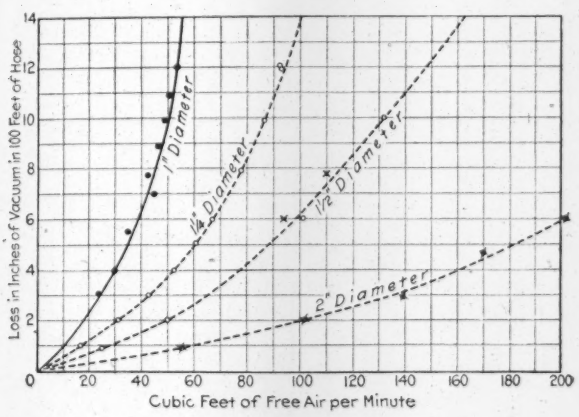


Fig. 2. Curves Showing Friction Loss in Vacuum-Cleaner Hose Lines

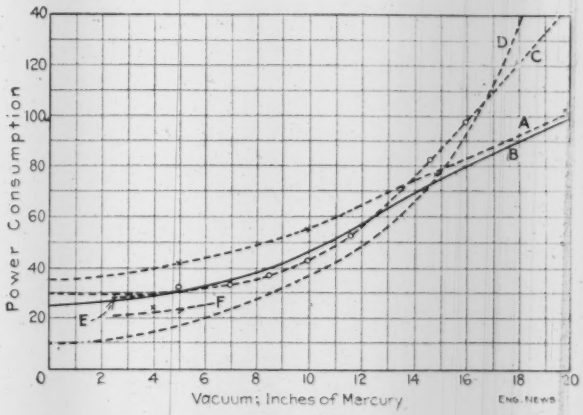


Fig. 3. Power Consumption Curves of Six Different Types of Vacuum-Producing Apparatus
(Power consumption shown in watts per cu.ft. of free air exhausted per min.)

Vacuum Pumps

Fig. 3 shows curves of power consumption of six different types of vacuum producers, based on tests made by the author. Curve *A* is from a reciprocating-piston air compressor used as a vacuum pump. Curve *B* is from a reciprocating-piston vacuum pump especially designed for vacuum cleaning and shows a higher economy than *A*. Curve *C* is from a single-impeller sliding-vane rotary vacuum pump and shows equal economy to *B* up to 12 in. of vacuum, above which its efficiency falls off. Curve *D* is from a double-impeller rotary vacuum pump, water sealed, which shows much better economy than *B* below 14½ in. of vacuum. Curve *E* is from an early type of multistage centrifugal fan and shows an efficiency about equal to *B* and *C*. Curve *F* is from a recent type of multistage centrifugal fan and shows an efficiency better than any other except *D*.

At 6 in. of vacuum these producers can be rated in the following order relative to efficiency: First, *D*; second, *F*; third, *B*; fourth, *E*; fifth, *C*; sixth, *A*. Type *F* maintains a constant vacuum due to inherent properties of its construction, and where first cost is of vital consideration its use might be preferable to that of *D*. Both *D* and *F* are subject to considerable noise and vibration unless the peripheral velocities of fan and impellers are limited. The author recommends a maximum velocity of impeller tips of 1100 ft. per min. in *B* and not over 1500 ft. per min. in *F*.

Summary

The author considers that to obtain the best results in a cleaning system the width of cleaning slot should be required to be not less than ½ in., the length of the renovator not less than 12 in., the diameter of the hose 1½ in.; that the pipe line should not be less than 2½ in. in diameter except where lifts occur, where 2 in. should be used; that the vacuum control be set to maintain 6 or 7 in. of vacuum at the machine.

The following test is suggested to give the best results: Fit a 1½-in. diameter pipe 3 ft. long into the end of the hose with a diaphragm at the outer end and a

vacuum gage or mercury column near the rose. Require a vacuum at mercury column of 3 in. with 65 cu.ft. of air passing into the tube and as many hose lines and tubes in operation as the number of sweepers desired in the system. This test will require approximately a $\frac{5}{8}$-in. diameter opening in the diaphragm.

Unit Reinforcement over Column Heads in Flat-Floor Concrete Construction

A unit system for carrying the steel reinforcement over the column heads in flat-slab floor construction of reinforced concrete buildings has been devised, on the same principle as the reinforcing units used in some types of concrete-girder construction. It is said to make an economical design, as the steel used to take care of the positive moment is as close to the bottom of the floor slab as possible, and the steel used to take care of the negative bending moment is as close to the top of the slab over an adjacent support as possible.

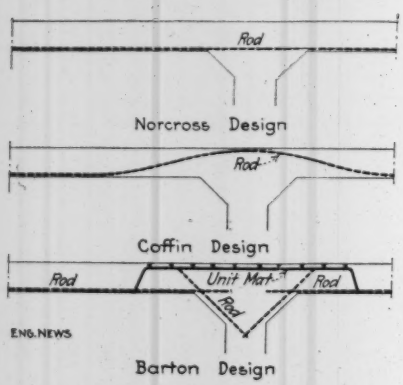


FIG. 1. DIFFERENT METHODS OF CARRYING STEEL REINFORCEMENT ACROSS COLUMN HEADS IN SLAB-FLOOR CONSTRUCTION

In 1902 Orlando Norcross patented a flat-slab floor on concrete columns, in which all the reinforcement was laid near the bottom of the slab. The inventor of the system here described states that later in the same year Freeman C. Coffin, of Boston (deceased), constructed the floor and column structure of a reservoir at the Bridgewater works, in which he raised part of the floor reinforcement to the top of the slab over the supporting columns using the catenary curve. These arrangements are shown in Fig. 1. It is stated also that while it has been the custom to follow Coffin's idea, an objection to it (where rods were used) was that the various belts crossing over the supporting columns constitute a conglomeration of rods, which the ordinary laborer failed to lay properly, and the bottom layers were below the tensile zone in the slab over and adjacent to the supporting columns.

The unit system (shown in Figs. 1 and 2) is claimed to overcome this objection by forming a ready-made mat of heavy rods, whose prime purpose is to take care of the negative bending moment over and adjacent to the supporting columns, and which cannot be laid anywhere except in the right place (at the top of the slab), while the ends of the slab rods are laid in stirrups formed on the ends of the mat. The mat is made of two layers of rods, which makes it possible to tamp the concrete of column and head, as the rods are spaced sufficiently far apart to allow of getting below the mat with a tamper. These unit mats have been used in the Mills Building, Chicago.

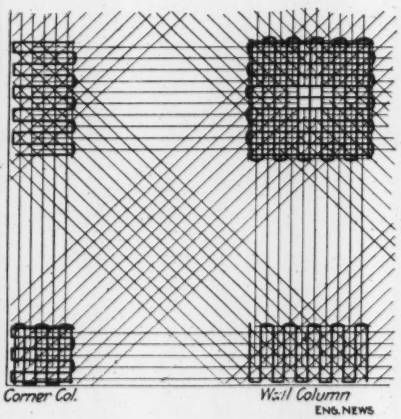


FIG. 2. PLAN SHOWING ARRANGEMENT OF UNIT MATS FOR REINFORCEMENT OVER COLUMN HEADS

Fig. 2 shows this unit system in plan. The designer calls attention to the zone of counterflexure, and states that the mat rods, slab rods and stirrups amply provide against any deformation. The mats are formed at the shops and can be shipped or handled one on top of each other, so that they require but little space so stacked. The inventor is Francis M. Barton, architect, 178 W. Jackson Boulevard, Chicago.

A Resilient Concrete Floor for use in factory buildings has been used for some time by a contractor in the Middle West, in which the surface coat is made up of a mixture of ground cork and portland cement, which is allowed to form a sort of concrete surface to the concrete base and which is covered when set with a finish of cement mortar. The cork layer is about 1 in. thick and the cement finish about $\frac{1}{2}$ in. thick. Similar effects have been reached in Germany by the use of a mixture of oxychloride cement with sawdust for the resilient layer.

Engineering Education in the United States*

BY HENRY SMITH PRITCHETT†

The profession of the engineer is one that within the last generation has come to be reckoned among those professions to be prepared for in a technical school or the technical department of a university. Engineering education now includes not only the various branches of the profession, civil engineering, mechanical engineering, mining engineering, and the like, but also other forms of technical professional vocations which rest upon applied science, such as the profession of the chemist, the electrician, and the bacteriologist. A whole series of scientific professions is thus embraced under the general term of engineering.

Beginning with comparatively simple courses, almost all schools of applied science have gradually increased both the complexity of their courses and the demand upon the individual student. This result is very natural as a result of the effort to teach new studies without neglecting any of the old ones. The applications of science have been so enlarged in 25 years that the effort to teach these applications in the schools of applied science has brought about an overloaded curriculum. There can be no question today but that these schools would turn out better engineers if they undertook to teach each man fewer subjects and to give him a better grounding in the fundamental sciences.

This matter has been the subject recently of considerable conference between the engineers engaged in the operation of large industrial establishments and the teachers in a number of the technical schools. An effort has been made to bring about a fuller understanding on the part of technical-school teachers of the practical demands made of the men that are sent out from the schools, and at the same time a fuller appreciation of whatever suggestions men in practice may have to make as to changes in the curriculum which will increase the efficiency of the technical-school graduate.

Several of the stronger engineering societies have undertaken detailed studies of the curricula of the various schools, and numerous conferences between technical teachers and practicing engineers have followed. No definite outcome of these studies has as yet appeared. The questions involved deal not only with the matter of engineering efficiency and the matter of successful teaching, but they touch inevitably upon the quality of the student offering himself to the engineering school. No study of the question can be fruitful if it neglects this last point of view. There is needed a patient and

*Extract from the Sixth Annual Report of the President to the Trustees of the Carnegie Foundation.

†President of the Carnegie Foundation for the Advancement of Teaching.

thoroughgoing study by competent men of the engineering curriculum and its relation to the preparation of the technical graduate for present-day industries.

It seems clearly shown by the experience of recent years that the number of institutions of applied science of a high grade in the United States is already large, and that more engineers are now being turned out annually than the country is able to assimilate.

The Foundation has had occasion to make several special inquiries into the field of engineering education. It found in 1906 records of the conferring of 2766 degrees in engineering—1786 bachelors of science in various kinds of engineering, and 980 other, mostly higher, engineering degrees. In 1910 it found records of the conferring of 3713 such degrees. These degrees included Bachelor of Arts in Civil, Electrical, and Mechanical Engineering courses; Bachelor of Science in Engineering, without specification; Bachelor of Science in Preparation for Engineering; Bachelor of Science in Architectural, Chemical, Civil, Electrical, Electrochemical, General, Marine, Mechanical, Metallurgical, Mining, Sanitary, and Textile Engineering; Bachelor of Engineering, without specification; Bachelor of Engineering in Architectural, Civil, Electrical, and Mechanical courses; Bachelor of Civil, Electrical, Mechanical, and Mining Engineering; Master of Civil and of Mechanical Engineering; Doctor of Engineering; and degrees of Chemical, Civil, Electrical, Mechanical, Metallurgical, and Mining Engineers; and Engineer of Mines.

There were also various combinations of these 38 degrees, and it is a rather common practice for the same institution to give two degrees in the same field, as, for example, both Bachelor of Civil Engineering and Civil Engineer, using one for undergraduate and the other for advanced courses. Several institutions give as many as nine, ten, or eleven kinds of engineering degrees, and some give honorary degrees in engineering. It would scarcely seem that 40 varieties of engineering degrees should long continue necessary.

Of the 102 institutions mentioned as granting engineering degrees in 1910, 25 granted less than 10 degrees each, 26 granted between 10 and 20 degrees, 23 between 20 and 50, 14 between 50 and 100, and only 9 institutions granted more than 100 degrees each. If one adds to this the fact that 27 states had more than one of these schools, 14 states had more than 2, 8 states more than 3, and some states as many as 8 or 9, it becomes apparent that there must be a considerable number of schools that would find it difficult to justify their existence.

The report of the United States Commissioner of Education for 1910 lists 110 universities, colleges, and technical schools giving courses in engineering, and even this list is known to be incomplete. It is possible to see why 10 states should have 2 schools each, perhaps why 12 states should have 3 each. But it is not so easy to understand why 5 states should have 4 each, and Indiana should have 5, California 7, New York 9, and Pennsylvania 13.

It is scarcely unreasonable to wonder what can be the justification for maintaining the equipment and organization that an engineering school should have, for the 6 students that comprise one of Indiana's 5 engineering schools, and the 11, 36 and 39 that comprise three of California's engineering schools. Even New York City can scarcely need six schools of engineering. It would seem that of Pennsylvania's 13 schools, those having 8, 16, 20, 33 and 40 students each would have difficulty in justifying their existence.

It will be noted, moreover, that the development of these schools has been quite independent of local needs. For example, agricultural states like Kansas and Iowa support two engineering schools, although the number of engineers required by such states is certainly limited.

The figures given above would seem to make it fairly evident that the great number of engineering schools now in existence will probably furnish in the future a larger number of engineers than the country can take up. In fact, on account of this pressure, many engineering graduates are today seeking other vocations than the engineering for which they have been prepared.

Letters to the Editor

The Electrolytic Treatment of Sewage and Water: Supplementary Note

Sir—Owing to the similarity between the name of our company and of the Electrical Water Purification Co., also of Philadelphia, mentioned in the review of attempts to treat water and sewage by electricity, in your issue of Mar. 21, we would appreciate the courtesy if you would state that that company is not to be confounded with the Electrolytic Purification Co., as there is nothing whatever in common between them, other than a similarity of names. We ask this because we have been confused with that company since the publication of your article.

The principles involved in our processes are both electrical and electrochemical and are simply the result of the application of the laws governing electrolytic action.

ELECTROLYTIC PURIFICATION CO.,
C. P. LANDRETH, Gen. Mgr.
43 N. 7th St., Philadelphia, Apr. 1, 1912.

[So far as we know, the company mentioned in our article disappeared from view some twenty years ago, or soon after its appearance. When our article was written we were unaware of the existence of the company whose manager wrote the foregoing letter.—ED.]

More about the Location of Borrow Pits in Levee Construction

Sir—Anent the location of borrow pits for levee construction, discussion of which has appeared in your columns of recent issue.

The position of the writer was plainly stated in your issue of Feb. 15, 1912. The letter from Gen. Marshall, appearing on Mar. 7, calls for a few brief remarks, but has not added to the writer's knowledge of the subject or caused him to modify statements previously made.

In support of his contention that landside borrow pits are not in themselves a menace to the maintenance of a levee, Gen. Marshall goes at considerable length into the drainage of earthen embankments and suggests that, with proper drainage in the rear of the levee to prevent the bank from being saturated, the structure will not be endangered as much as it would be by a river-side borrow pit which cut through impermeable strata and opened up water-bearing seams in the foundation. He cites instances of drainage on the land side of the levees built at New Orleans and in Holland. It is well known that oftentimes on the land side of levees the ground becomes saturated and cannot be entered upon for ordinary uses. Drainage under such conditions is sometimes introduced in order that the land may be rendered useful, but there is plenty of evidence to show that excavation for such purposes is a source of weakness. The drainage systems that the General refers to at New Orleans and in Holland were introduced, in the opinion of the writer, more to make the area affected habitable than to increase the sta-

bility or safety of the levees in front. Upon the degree of porosity of the soil in the levee and in its foundation, governing in a measure the rate of percolation of water to the rear of the structure, would depend to a large extent the success of drainage ditches in the rear. If the rate of percolation was so great and the underground so weak that sand boils were created, it is probable that drainage would not afford the needed relief. Under some conditions the cutting of drainage ditches behind the levee reminds one of the man who wet his foot through a hole in the toe of his boot. After careful consideration he adopted the "heroic" remedy of opening a hole in the heel the same size as the one in the toe, reasoning that, with the entrance and exit of the same capacity, his foot could be kept dry.

The following is from Gen. Marshall's letter:

> Mr. Sellew seems more daring. Not only does he cut his checkerboard borrow pits on the river side, giving by his own account more easy communication between the river and alleged ground water, but he also cuts an irrigating canal on the land side of his levee, again breaking the crust, and fails to explain wherein the effects of the latter will differ from those he attributes to land-side borrow pits within two miles of his work.

It is contended that along such streams as the Colorado the existence of river-side borrow pits is not a menace when due regard is given to their size, protection, and the construction of the levee. If, in the course of excavation, permeable strata are encountered, these strata are cut by the muck ditches which, in all work under the writer's direction, have been of ample depth, and in the bottoms of these ditches exploration with post augers has continued until the strata within 8 or 10 ft. of the surface have been thoroughly examined. In addition to interrupting the permeable strata by this muck ditch, the first flood water from the Colorado with its heavy load of silt will choke the open material where it has been exposed, and after a flood of ordinary proportions the river side of the levee is practically as impermeable as it was before the borrow pits were excavated. Then, too, in most cases a few floods will fill the pits with sediment, thus restoring original conditions.

In regard to the location of an irrigation canal on the land side of the levee: This was done from necessity. In the location pointed out by Gen. Marshall the land next to the levee was the highest, and that is the natural point upon which an irrigation canal should be built to properly supply the lands it is to serve. This canal is principally above the ground, and the amount of excavation below the surface is slight. In addition, the canal is generally full of water, which, in a large measure, compensates for the weight of the material taken from the canal excavation. The location of the canal in this position was not considered the best practice, but there was no other place for it. It is in the same category as the drainage ditches which he mentions that were placed inside of levees to relieve the ground-water conditions: such drains could not be placed elsewhere. Natural conditions or emergencies sometimes force a line of action which, while the best that can be done under the circumstances, should not be taken as a precedent for general practice. A man who is snowbound might, in an emergency, split up a chair for firewood. Such action on his part, however, would not justify a continual resort to the furniture for such purposes.

Gen. Marshall appears to doubt the proximity and sensitiveness of underground water along the Colorado River in the vicinity of existing levees. He states as follows:

> If such free underground flow and high ground-water level exists there as is necessary to justify this opinion as to the causes of destruction of the levee, it is very difficult to understand why all the extremely fertile land in that vicinity has not long since been brought under cultivation by pumping from such free and shallow supply, unless, indeed, one can believe that nature has provided a stratum at just the level and porosity best adapted to destroy levees having land-side borrow pits, but of no useful avail—a devlish not godlike arrangement.

The writer wishes to reiterate that ground water in this vicinity acts as shown in his former letter, and to suggest a few possible reasons why the advantage has not been taken of it for cultivation, viz.: the limited amount obtainable by this method; the cost of pumping when gravity flow is available; the uncertainty of the life of wells driven into the strata, owing to their becoming clogged with fine sand; and the better agricultural results to be obtained with the silty water from the river than from clear water below. (Attempts were made in Yuma Valley some years ago to irrigate from driven wells, but no appreciable supply was obtained owing to the clogging of the pipes with fine sand.)

Gen. Marshall further states:

> It is useless to go further along these lines, but even in the narrow sense of this discussion it is susceptible of proof that any extensive excavation on either side of a levee not provided with core walls or drainage systems, and near the base of the levee, will diminish its stability. The levee will be most stable if there be no break on either side.

It is believed that levee engineers will take no exception to the statement that the stability of a levee is impaired by excavations in its vicinity on either side, unless such excavations are refilled. However, there is little to be gained from the discussion of conditions which can never exist, for as long as levees are built, borrow pits must be located on one side or the other. Conditions being equal, the writer will take a location on the river side, depending upon the water-borne sediment to ultimately obliterate the pits, in preference to one on the land side where excavations must forever remain open—a blot on the landscape and a menace to the work which creates them.

FRANCIS L. SELLEW.

Yuma, Ariz., Mar. 22, 1912.

Conservation Engineering at the University of Michigan and Engineering Degrees

Sir—The editorial in your issue of Dec. 28, in which there appeared a criticism of the course in Conservation Engineering at the University of Michigan, has occasioned considerable surprise among your friends. The relations between ENGINEERING NEWS and the Engineering Department at Michigan have always been so pleasant that it gave us something of a shock to find ourselves suddenly singled out for your special reproof. It seemed a bit unfair, too, to attack a condition at Michigan which is common to practically all the engineering schools in this country, for while our course in Conservation Engineering furnishes you the text for your comments, the point of it, of course, is that academic degrees have multiplied and replenished the earth beyond all reasonable endurance. With this thesis we heartily agree, and we assure you that any effective plan for their extermination will be welcomed. We did, however, resent somewhat the impression which your editorial gave that we were chief offenders in this matter.

Perhaps it was no more than human for us to find ourselves stung by your reproof into a rather critical attitude toward your editorial. I am sure that when you see how graciously we have borne the bitterness of your displeasure, you will not deny us the privilege of a courteous statement of what we find unsatisfactory in your treatment of this problem. Your editorial, it seems to us, has treated the perplexing question of the use of college degrees in general, and of their use in the technical schools in particular, without a sense of their real significance, and without a proper feeling for the historical background of the subject. Such a handling of this theme is in our judgment misleading, and—this is a most unkind word to apply to an utterance from such a source—a shade academic.

The degrees, as your editorial writer must, of course, have known, have had a long and honorable history. Originating in the medieval universities where Latin was the common speech for students of various tongues, they have descended from generation to generation, from one educational epoch to another, outliving the very institutions for which they first stood, till, centuries old, they have become a part of the inheritance of our American universities. A study of the narrowing and widening of their significance, as they have served the vary-

ing purposes of varying ideals in education and in society would lead one well over the history of education. So distant is their origin and so long and tortuous the way they have come that they descend to us as mere conventions. Their old meaning is largely gone, but they seem still to serve a useful purpose.

The universities and colleges of our time, always slow to throw away anything traditional, because of their sentiment for the past and their love of continuity, have done what colleges and universities in every other time have done; they have made the old degrees serve their own immediate ends.

The precise character of this service is the point which we feel the writer of your editorial should have left less hazy.

As life became more complex, preparation for life also became of necessity more complex. The division of labor, the progress of invention, the differentiation of industries, the application in a thousand ways of science to life, have meant the opening to the individual of a variety of new activities, for which he must be equipped. And education came to be more sharply defined in the minds of both educators and the general public as preparation for life. The application of psychology to educational theory, taking form in this country in the early eighties in child study and adolescent study and the other studies of special periods of growth, laid emphasis also upon a new conception—the right of the individual, even in a general preparation for life, to choose his means of development according to his own bent, to base his choice of subjects on an intelligent study of his own possibilities.

Thus both the demand of a practical world and the force of a new educational ideal have compelled our colleges in the past fifty years to reconstruct their curricula in such a way as to satisfy the multiple needs of the individual and of society. It has meant, in fact, not merely the introduction of new courses but the classifying and grouping together of such subjects as were judged best fitted to prepare for certain definite ends. As the old academic degrees had for centuries stood for the completion of a certain number of allied subjects, it was the most natural thing in the world to use them now to designate these groups of studies. The scholastic convention, around which there had in the past, it is true, gathered a deal of sentiment, became a practical convenience in the administration of the new curricula.

That anyone, at this late date, should proceed, lexicon in hand, to translate and interpret literally any of these academic symbols, is surely not at all to be expected. The degree means nothing more than that the student has completed satisfactorily a certain group of studies. Everyone who comes in touch with college life recognizes this meaning. The writer of the editorial himself admits this use of the degree in the nontechnical college. He says:

> It is not worth while to criticize the time-honored custom of granting the degree of Master of Arts to a student who has completed a four-years' course and done post-graduate work, because everybody knows that the recipient of such a degree is far from being actually a Master of Arts, and is often master of nothing except a few scholastic requirements.

Precisely: as Dean Cooley has said, he is no more a master of arts than a drug clerk is a master mason because some lodge has granted him that degree. And everybody so understands it. No one suspects the lodge of false dealing, any more than he does the college with the master's degree. The public understands that the degree means practically nothing except in connection with the college itself, where it is a convenient way of indicating both to the student and to his friends the groups of foundation studies offered.

But while the editorial writer condones the use of the degrees in the nontechnical schools, because of the general understanding of how significant they are, he thinks that, "when the engineering schools adopt this fetish of the old-time college and apply it to their students, the degrees become so absurd that no graduate with common sense cares to use them." It is not worth while, he thinks, to criticize the use of the degrees in the college, although there has been there an opportunity, centuries long, to discover their empty sound and to devise some more satisfactory nomenclature. Yet in the engineering schools, which have been hustled into being mostly within less than a half century, their continuance is, according to the editorial, an affront to reason, a cheap advertising scheme, intended to attract students by holding out to them false promises of success.

Such a treatment of the subject is hardly fair, and, you must admit, ignores the historical development of the engineering schools entirely. One might suppose that the technical schools were made to order, carpentered according to a logical set of specifications, equipped like the "furnished cottages" on exhibition in the department stores, perfect in every appointment, having a no less perfect past and doomed not to have a more perfect future. Schools are not so made. They grow, and like every other evolving organism grope their way, sometimes slowly, toward a more perfect performance of their function. The engineering schools have developed from an honest effort of education to keep pace with the industrial development of the past half century.

They were in many cases at their beginning merely courses in the literary departments of our colleges. With the growing demand for engineers, they began less than a quarter of a century ago, to split off into independent departments. In consequence they naturally used the machinery of administration which had come to them from the older colleges out of which they had grown. They did not "copy" nor "adopt the fetish of the old-time degrees"; they inherited it, and as they had a quarter century of tremendously real hard work to do in keeping up with the growth of the engineering field, they had neither time nor attention to devote to reform in such educational trifles. They continued to use the degrees, as they had long been used, as a convenient means of indicating the groups of subjects to be pursued by their students.

It is really not at all probable that anyone should be misled by the use of these names, applied though they be in a new field of thought. A Master of Science, graduated from the Literary Department of a modern college is everywhere recognized as a man who has completed a certain amount of scientific study. It is merely puerile to refuse to recognize the Master of Science in Engineering to be somewhat akin to his chum who is graduated on the same day, from the same rostrum, by the same board of regents. As a matter of fact, no one in or out of the engineering school does really mistake the significance of the degree.

The multiplication of degrees in the engineering schools has been inevitable. The engineering profession, for which these schools prepare, has been forced by the keenness of competition and the necessity of expert service to specialize in many new lines of work. There are today a score of special engineering fields where 25 years ago there were at most perhaps a half dozen.

In order to give the foundation needed for these diverse forms of engineering, the school has had to provide groups of subjects differing slightly in detail; and an attempt has been made to indicate each of these groups consistently by a degree. That this process has never been pushed to its logical extreme is certainly fortunate. There are, for example, at least seven or eight different groups of special studies, which at present are designated merely by the term Mechanical Engineering; the same might be said of Civil Engineering. The multiplication of degrees has gone far enough, however, and as the schools have not been uniform in their usage, it has resulted in a perfect chaos of technical degrees.

One thing should be carefully noted here, and it is a point that the writer of the editorial has seemed to leave somewhat vague. These degrees do not, as might be supposed, indicate any great amount of specialization. We fully agree with your writer that specialization in engineering education is in almost all cases a mistake. The foundation work, however, preparing for one kind of work

does differ in kind from that for another. The grouping of subjects indicated by the degree means merely a shaping of the preparatory work in the latter part of the course so that the young man may more easily adjust himself to his work.

The embarrassment of riches in this matter of degrees, is nowhere more regretted than in the engineering schools themselves. Reform is needed. Dean Cooley deplores frankly the large number of degrees. He says: "I would like simply to write 'Engineer' after the name of every graduate." Almost all the men on the Michigan faculty with whom I talked feel keenly the desirability of correcting a state of affairs that is confusing. In several of the Colleges of Arts experiments are even now being made with the purpose of reducing the number of scholastic degrees. Perhaps a like simplification of the system now in use in the engineering schools will follow. Certain it is that this is one of the problems to be solved in the near future.

In conclusion, I should like to ask as frankly as I can the questions which your editorial has seemed to raise in our minds.

1. Is it altogether reasonable to expect the technical schools, the newest experiment in education, to be the first to reform such minor details of administration as the use of degrees? They have been so busy growing.

2. Is it really sensible to base a criticism of the use of these degrees upon the supposition that anyone, employer or employed, will interpret them literally and without a sense of their conventional use?

3. It it quite fair to attack a condition at Michigan which is everywhere common and exists in several schools in a most extreme form?

4. Is it—well, may I be frank—is it just professional courtesy to insinuate that Michigan or any other self-respecting school offers these degrees as a bait to catch patronge? Our problem as you know is to manage by some inspired economy to keep our equipment up to the demand made upon it by the overwhelming number of students.

5. Finally, is it fitting an organ like the ENGINEERING NEWS to approach the discussion of such a matter, as it has in this editorial, with so little feeling for historical perspective and with so little appreciation of the real problem involved?

Upon one point—and I am glad to admit that it is after all the important point—upon one point we are agreed: the multiplication of degrees has gone to a needless and confusing extreme, which is especially to be regretted in the engineering school. This presents one of the problems which these schools must solve in the near future.

Till the solution is found, we have a right to expect from you, as the medium of communication between our little world of theory and the big world of practice, all the intelligent and sympathetic help possible. It is hardly necessary for me to add that we feel sure we shall have it, and that this latest exchange of greetings though in the nature of mutual criticism may only serve to emphasize our common interest in engineering education.

J. RALEIGH NELSON.

Engineering Department,
University of Michigan,
Ann Arbor, Mich., Mar. 6, 1912.

[We have commented on the above letter in our editorial columns.—ED.]

History of the "S. P. R. R. Transit" and Another of Its Engineering Poems(?)

Sir—The letter in your issue of Mar. 14, from J. H. K. Burgwin, and his poem entitled "Recrimination," has prompted the writer to inclose a boyish production of his own, another one of those unsigned poetical attempts published in the S. P. R.R. *Transit* of 28 years ago.

During the construction of the South Pennsylvania R.R., a work extending over a distance of 300 miles, and therefore widely separating friends and acquaintances, some of the young engineers of the Somerset division conceived the idea of sending a circular letter to the corps at one end of the road, requesting them to enter a record of their work to date with anything of professional or personal interest, then to pass it on to the next residency, all the data to be compiled for distribution after the circuit.

The scheme met with instant success; the circular letter was returned with such a mass of interesting information and news that the publication of a regular monthly magazine called the S. P. R.R. *Transit* was decided upon, with L. W. Fogg, its originator, as editor.

The magazine was supported and contributed to by the various construction corps of the railroad engineering force, helped often by members from the contractors' camps and by the contractors themselves, and was made up of personal notes and items of interest concerning the condition of the whole line from Harrisburg to Pittsburg. The contributions to this magazine covered the whole field of work from blueprint processes to descriptions of graphical methods for computing earthwork or overhaul, not forgetting many poetical effusions in more or less uncertain meter upon subjects kindred to the work.

Much to our regret the publication came to a sudden end, receiving its death warrant from headquarters, owing to an unpardonable criticism concerning the capacity of a certain arch culvert, and the clearance at an undergrade tunnel crossing. The last number appeared heavily draped, and typed in black, entitled "Obituary Number." Thus the *Transit* came to a too early death through the unreasonable exuberance of youth, calling to task our superior officers, who were none other than that distinguished and beloved trio of pioneer railroad engineers, Robert H. Sayre, Oliver W. Barnes and William F. Shunk.

The writer's contribution to Vol. 1, No. 1, March, 1884, of the *Transit*, entitled "The Lay of the Last Laborer," was suggested by the endless string of laborers tramping the roads for work, continually stopping at the little engineer's office of the writer, located at the foot of the mountain six miles from the summit of the west range of the Alleghanies, where the one-mile long tunnel was being driven, usually leading their inquiries there with questions about the tunnel, how far it was, etc., and then finally requesting a light for the pipe.

The only excuse for presenting this crude doggerel is the surety that many similar scenes and incidents will be recalled by the older railroad engineers and contractors among your readers, who have spent long lives in conquering the wilderness in the advance of civilization. This inevitable army of laborers along the dusty roads or mountain trails, with its pathetic and also its enlivening sides, always pushing ahead for the goal of prospective work, or for the camps of some former boss, was fully illustrated here.

CHAS. W. STANIFORD,
Formerly, Resident Engineer,
Sub. Div. "D," Div. 5,
South Penn. R.R.

Chief Engineer,
Department of Docks and Ferries,
New York City, Mar. 25, 1912.

[We reprint below the first four of the six verses of Mr. Staniford's early effort. —ED. ENG. NEWS.]

THE LAY OF THE LAST LABORER

"How far is it up to the tunnel?"
Is the question from morning till night.
"We're after work. If it's not too much trouble,
Please, Sir, will you give me a light."

"As they flock from every direction"
Every race; fair Saxon, dark Muscovite,
Reminding one of some mournful procession
Or the stragglers in Napoleon's retreat.

Every nation is here represented,
With Erin, premier, number one;
The "last minstrel" sounds resurrected,
By a "lay" from a troubadour's tongue.

The main question's "where to get boarded?"
'Tis hard to lie out in the snow.
And when the last roll is recorded
The laborers are still on the go.

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Contents

*The Failure and Repair of the Winston (N. C.) Water Works Dam; J. N. Ambler 667
*A Typical Design for Division Engine Terminals. 669
*Improving the Upper Mississippi River; E. F. Linderman 670
*Pitometer Survey of Artesian Wells at Clinton, Iowa 673
Forests and Floods on the North Pacific Coast; H. M. Chittenden 674
*Concrete School Buildings in the Philippines 675
*Widening the Smithfield St. Bridge at Pittsburg, Penn., by Shifting One Truss 676
Construction Cost of the Sewage Purification Works at Washington, Penn; Donald M. Belcher 680
*Surveys for a Submarine Rapid Transit Tunnel; Frederick C. Noble 682
Secondary Stresses in Bridges 685
*Interurban Railway Station at Wheaton, Ill. 686
The Use of the Great Lakes; R. R. McCormick 687
*A Simple Automatic System for Lawn Sprinkling, Los Angeles, Cal.; Burt A. Heinly 688
The Effects of Tars and Other Road-Dust Abating Substances on Fish Life 689
*Electric Traction Developments in London 690
Condensed Report of the Water Works of Battle Creek Mich., for 1911 691
*Tests of Vacuum Cleaner Apparatus; M. S. Cooley 692
*Unit Reinforcement Over Column Heads in Flat-Floor Concrete Construction 694
Engineering Education in the United States; Henry Smith Pritchett 694
LETTERS TO THE EDITOR 695
The Electrolytic Treatment of Sewage and Water: Supplementary Note; C. P. Landreth—More About the Location of Borrow Pits in Levee Construction; Francis L. Sellew—Conservation Engineering at the University of Michigan and Engineering Degrees; J. Raleigh Nelson—History of the "S. P. R. R. Transit" and another of Its Engineering Poems(?)
EDITORIAL 699
The Appointment of Civilians to the Engineer Corps, U. S. Army—The Threatened Strike of Locomotive Engineers—Cracks in Bridge Piers—More Concerning the Degrees Granted by Engineering Schools—Lessons of the British Coal Strike.
*The White River Power Development in Washington 704
*A Radical Inovation in Street Car Design 708
New Subway Routes and Progress of Subway Construction in New York City 709
*Visit of the Bavarian Technical Museum Commission to the United States 710
Annual Meeting of the Lake Michigan Sanitary Association 710
ENGINEERING NEWS OF THE WEEK 712
PERSONALS 713
ENGINEERING SOCIETIES 714

*Illustrated.

Engineering News

A radical departure from old designs is seen in the new street car which has recently been put in experimental service in New York City, as described elsewhere in this issue. For about a quarter century, car designers have worked forward in a rut; the modern electric car shows that it is a grown-up horse car. Even the prepayment feature, which made a radical change in the old operating methods, brought only an abnormal extension of the rear platform; it obviously was still an orthodox street car.

Messrs. Hedley and Doyle, the designers of the new car, broke away from current ideas, realizing from experience the benefit, to the company and the public, of certain operating features of the New York subway equipment—no steps, center doors, guide stanchions, etc. If we examine vehicles, other than railway, ample precedent is seen to predict the success of the cradled arrangement of body and trucks in this car which brings the floor within the height of an easy step from the ground. The design exhibits many other interesting innovations—all of which illustrate the benefit of attacking, from a fresh point of view, practice which has become standardized to a standstill.

The New York *Sun* preaches a sermon against government ownership of railways, taking as its text the Panama R.R., which has been owned and operated by the United States government ever since the French rights on the Isthmus were purchased, ten years ago. The *Sun* says:

> Not only has the government as proprietor of this railroad neglected to insure its continuance in its present character of public highway, but the capacity of the line for commercial purposes is actually to be reduced. Its double tracks are to disappear, a single track taking their place. It will not accept larger consignments of freight; it will not accept even as much freight as it has in the past. As a factor its transcontinental competition is to be lowered in efficiency. Nor can this reduction be attributed to a purpose to abandon the road on the completion of the canal. It must always be maintained as a complement and protection for the great ditch.

The *Sun* ought to exercise more wisdom in choosing texts for its sermons. If any advocate of government railway operation desired to illustrate its advantages over private management, he could hardly find a better example than the Panama R.R. The contrast between the scrap-heap which it was when the government took possession of it and its condition as rebuilt and operated by the government engineers, has actually caused a good many people to think more favorably of government railway operation.

As for the *Sun's* criticism because the road is being rebuilt as a single-track line, the *Sun* probably does not know that the old Panama R.R., under private ownership and management, was a single-track line. Also it doubtless forgets that a ship canal is nearly completed across the Isthmus alongside the railway, which will take away from the latter probably 95% to 98% of its traffic.

There is no doubt at all that if a private company were building the canal they would have arranged to either abandon the railway entirely on completion of the canal or have built the cheapest sort of a line across. Nothing but possible military considerations have justified the government's present expenditure in reconstructing the Panama R.R.

The Appointment of Civilians to the Engineer Corps

Some months ago we announced in these columns that for the first time commissions in the Corps of Engineers of the U. S. Army were to be opened to civilians instead of being restricted, as had been the custom, to the honor graduates of West Point, and that an examination to fill ten vacancies in the corps was to be given on Jan. 12 of this year. At that time we took occasion to recommend this opening to bright young engineers and to express the opinion that the competition for so exceptional an opportunity would be most keen. It appears to us that to be an officer in the Engineer Corps of the U. S. Army is an honorable estate well worth the efforts of any young engineer, particularly in view of the widespread discontent with the future prospects in civilian engineering. It is, then, with some surprise that we note that only four men presented themselves for examination last January and that of the four only one so satisfied the requirements as to obtain an appointment.

At first glance the lack of interest in the examination might be supposed to be the same as existed some years ago in the examination for the Corps of Civil Engineers in the United States Navy, where the restrictions in possibility of advancement, coupled with the extreme rigidity of the examinations, resulted in an absolute neglect of the advertised examinations through a period of some two or three years, with the result that the government was forced to appoint to the corps, without examination, a number of

Naval Academy graduates. In the Engineer Corps of the Army, however, the prospects of advancement are certainly much better than in the similar corps of the Navy, and the work which comes to its hands is much more interesting. Furthermore, the examinations as advertised were not too difficult for the graduates of a reputable engineering school, so it appears that the reason must be sought elsewhere.

In all probability it is to be found in the short time which intervened between the announcement of the examination and the examination itself, and in the restrictions imposed by the eligibility rule. It was not until the first part of November that the War Department issued definite notice of the examination to be held in the first part of January. Even the short period of two months in which to brush up for a difficult examination would deter most young men from entering a competition of this sort, but the orders specified that only those then employed in the engineering department of the War Department, or eligible to appointment by virtue of having passed the prescribed examinations, would be eligible for the examination. Members of other departmental services could be transferred to the War Department at request and thus render themselves eligible, but all other engineers would have to take, previous to the Engineer Corps examination, an examination making them eligible for the departmental or War Department service. This, then, cut down the period possible for preparation by at least another month, leaving only two or three weeks for those outside engineers who wished to make themselves eligible for appointment.

The lack of interest in the examination this year is no fair measure of what may be expected in the future if the practice is continued and announcement of the examination is given long enough beforehand. Positions in the engineer department at large of the War Department have always attracted a number of the younger men in the profession and there does not seem to be any good reason why a permanent position in the Engineer Corps itself should not be deemed much more desirable.

The Threatened Strike of Locomotive Engineers

The locomotive engineers of fifty railways in the territory between Chicago and the Atlantic seaboard and north of Norfolk, who are members of the Brotherhood of Locomotive Engineers, have made demands on the railway companies for an increased wage scale. These demands have been refused by the railway companies on the ground that railway revenues at the present time will not admit of such an increase in wages. The increase asked for would add about 18.63% to the present pay of the engine runners and would add about $7,500,000 to the operating expenses of the railways concerned. A strike ballot is now being taken among the engine men on the question whether the general officers of the Brotherhood shall be authorized to declare a strike in case the railways will not yield to the demands.

It would be difficult to exaggerate the serious consequences which would result from such a strike. It would effect a more complete and prompt paralysis of all industry by far than a strike of the coal miners. Not only would all factories have to stop, with their supply of fuel and raw materials cut off and no way of carrying their goods to customers; but in every city the inflow of provisions would be stopped and famine would at once appear.

It may freely be conceded that the railways cannot be operated without the engine men. Green strike breakers cannot safely be put in charge of trains on crowded trunk-line railways, and it would be impossible to obtain experienced locomotive engineers to replace the 30,000 odd men now in charge of railway locomotives. But because these men have the power to bring about a national calamity of stupendous proportions is the very reason why they should exercise their power with discretion. American locomotive runners are not paid low wages. The Interstate Commerce Commission statistics show an average daily rate of pay for engineers in this district in 1909 of about $4.30 per day, and this rate was raised 10% in 1910, making the present average rate nearly $4.75 per day. On the Pennsylvania R.R. system the average annual earnings of engineers in 1911 was $1,546.34, which was an increase of 39% over the average rate in 1890. In addition, many of these engineers not running on full time earned an additional amount as firemen. The average daily earnings of all engineers employed by the Pennsylvania R.R. Co. in the year ending June 30, 1911, were $5.44.

The engineers are already receiving wages far in excess of the rates paid to any other class of railway employees and in excess of those paid in any other country in the world. If their demands were granted, at least as large a percentage of wage increase would inevitably be demanded by all other classes of railway employees. That railway earnings will not permit such an advance without bankruptcy is only too evident.

Cracks in Bridge Piers

Our description of a highly interesting piece of reconstruction work on a Pittsburg bridge, printed in this issue, gives the careful engineer reason to consider the subject of cracked masonry in a new way. Cracks in masonry are by no means rare, but, while they always are eyesores and indicate undesired settlement, they seldom threaten serious and imminent danger. But cracks in the piers of a heavy, important bridge are another matter. They generally mean that the destruction of the piers has begun.

In the case of the Smithfield St. bridge, the foundation is heterogeneous and the bottom is soft material. Settlement is always possible on such bottom, but (under conservative loading) it is harmless if the structure resting on it is strong enough to hold together. To illustrate: In sinking pier caissons the work consists of producing *artificial* settlement by digging out the supporting bottom, and in this work the distribution of load is constantly varying, which produces changing stresses in the caisson material. The risk of attaining such one-sided settlement that the caisson can tip over is quite remote; the process is normal and safe so long as the caisson is strong enough to resist any possible load-distribution on its bottom. A bridge-pier caisson which was sunk last year at another place in Pittsburg gave a clear example that this strength *must* be provided: the caisson broke its back because material was dug away faster under its ends than under its center. Evidently the same unfavorable stressing may occur in a finished pier from unequal settlement.

Piers are usually so strong in the direction here in question that they are proof against breaking-moments due to settlement. But once they show evidences of having broken, it becomes a serious problem what to do. Further settlement now means not merely a change of stress distribution within the pier, or slight and unimportant tilting, but a direct continuance of the disintegration of the pier.

The matter is very easy to decide on a merely qualitative basis: the cracks in the pier are undoubted evidences of damage, and the pier will not be as good as it should be unless thoroughly repaired or rebuilt. The quantitative aspects of the case make it more difficult; how much is the efficiency or security of the pier reduced by the cracks, and how soon should reconstruction be started? To rebuild such a pier will cost a great sum, and the authorities are unlikely to appropriate the money until the work is absolutely necessary.

Pittsburg only recently went through a tedious and expensive case of similar kind. Another Monongahela River bridge had a crack in a pier, extending from the top inside of the truss shoe to the end face some distance below the shoe. The whole corner of masonry which carried the shoe was virtually cracked off, but it stuck to place and continued to carry the shoe load. The pier was left in this con-

dition for years, while the city authorities were discussing whether and how to repair it; and against all reason the pier did not drop the bridge into the river, but continued to hold it up. Finally reconstruction was started, and ultimately the pier was completely rebuilt (under traffic), at very great cost. The whole history of the case was such as to discourage prompt action in starting repairs in further cases of like kind, and induce a tendency to let matters run along indefinitely.

We believe that such a tendency in the present instance would be gravely wrong. The fact that the other pier stood in its broken condition so long should be a warning not to tempt fate again in similar manner. The South 22d St. bridge existed for years in a state threatening collapse at any time; to rely on equal luck a second time can hardly be recommended. Cracked bridge piers are not fit matters to trifle with.

More Concerning the Degrees Granted by Engineering Schools

In December last we received a circular respecting a six-year course in conservation engineering established by the University of Michigan. We assumed that this document was sent to us for such publicity and comment as we chose to make. In our issue of Dec. 28 we made such comment, stating that in our opinion the establishment of conservation engineering as a distinct branch of the profession was a mistake and hence that the creation of special courses planned to fit men for such a branch was likewise a mistake. We also criticized the granting of so called master's degrees for the completion of advanced work in engineering schools.

We had some hope that this brief preachment might not fall on stony ground, and the letter published elsewhere in this issue from Prof. Nelson, of the University of Michigan, indicates that our hope was realized, to some degree at least. If any of the other readers of ENGINEERING NEWS at whom the preachment was aimed failed to be duly impressed as to the importance of reform in connection with engineering degrees, Prof. Nelson's letter in this issue will lead them, we hope, to bring forth fruits meet for repentance.

As we read Prof. Nelson's letter we are reminded of an old story concerning a small boy who, when his mother applied vigorous corporal punishment for some act of disobedience, exclaimed, between his sobs, "Oh, you hurt." To which the stern mother replied as she continued the punishment, "My son, I mean to hurt."

It is almost needless for us to say that the application of this story is not that we meant to hurt the feelings of our good friends at the University of Michigan; but we did intend to speak so pointedly and forcibly that there should be no mistaking our meaning as to the injury which is done to the cause of education and to the engineering profession by present practice in granting engineering degrees. We readily grant, of course, that the University of Michigan is no worse than other engineering schools, and better than many in this matter.

At the close of his letter, Prof. Nelson submits and requests answers to five questions. The first is as to whether it is reasonable to expect the technical schools to have gotten around to reform such minor matters as their degrees? "They have been so busy growing."

The best answer we can make to this question is to ask whether any business concern would dream of presenting such an excuse for continuing a bad practice? Let us not forget that all the engineering schools which rank in the class of the University of Michigan have been in operation now more than a quarter of a century. Suppose a manufacturer of food products were hauled before the courts today on the charge that he was sending out packages labeled "Choice Butter from Selected Jersey Daries," whereas what the package actually contained was the poorest grade of oleomargarine. Would it be accepted as a valid excuse for his misleading label that he had been so busy for the past twenty-five years attending to his growing business that he had not had time to prepare correct labels?

Prof. Nelson's second question is as to whether anyone interprets the current engineering degrees literally, without a sense of their conventional use. It seems to us that this question really misses the point of the discussion. The essential absurdity of the present engineering degrees is that words of ordinary and well known meaning are taken and given a conventional significance in imitation of the conventional terms used as degrees in the old-fashioned classical courses. We need only say in reply to this question that for twenty-five years and more it has been a standing source of complaint among engineers that the mere completion of a course in college gives a man the right to write "Civil Engineer" after his name. This fact alone has so cheapened this title that few engineers of good standing now care to use it.

Prof. Nelson's third question is whether it is fair to attack a condition at Michigan which is everywhere common and exists in several schools in a more extreme form? Let us say in answer to this question, first that we are well aware that the University of Michigan does in general what other engineering schools do in the matter of degrees; second, that our criticism was aimed at a specific case, as any criticism must be to be effective. The University had established a six-year course in conservation engineering and it offered to grant to the students completing that course the degree, "Master of Conservation Engineering." Regardless of what errors other engineering schools might or might not commit along similar lines, it seemed to us that this was a departure which deserved the criticism we gave it.

Question 4 on Prof. Nelson's list is whether it is professional courtesy to insinuate that any self-respecting engineering school offers its degrees as a bait to catch patronage? We do not intend to transgress any canons of professional courtesy; but we discern no discourtesy in the plain statement that all our engineering schools do actually do the things which they believe will attract to themselves a large number of students of a desirable class. Does the offer of degrees have any attraction to students? Is there any engineering school strong enough to refuse to grant them? We fancy not a few of the readers of ENGINEERING NEWS can look back to their school days and recall the discussions that went on among the students as to the relative advantages of different schools of engineering and among others the different degrees granted by these schools in the days when to the youthful imagination a degree meant vastly more than it does today.

Finally, Prof. Nelson asks if it is fitting for ENGINEERING NEWS to have approached the discussion of this matter with so little feeling for historical perspective?

We confess to a certain vague uncertainty as to just what this means. If it means that we gave no hint in our criticism as to the origin of the present custom of granting degrees, we think our readers who refer to our issue of Dec. 28 will absolve us from the charge. We there briefly pointed out that the old degree "Master of Arts" had come to have a recognized technical meaning, and that the absurdity lay in trying to transfer this old technical meaning to new terms which could only bewilder all outside of academic circles.

There is underlying this question, however, as well as in other parts of Prof. Nelson's letter, the intimation that this attack of ENGINEERING NEWS is too sudden. The schools, it is said, have not yet had time to set their house in order. We ought apparently to have given them mild warning five or eight or ten years ago. Now it happens that in penning the criticism which has brought forth Prof. Nelson's excellent letter, we had distinctly in mind a previous discussion of this subject in the columns of ENGINEERING NEWS. Twenty years ago the late Arthur M. Wellington, then one of the editors of this journal, prepared a series

of articles on the engineering schools of the United States. In one of these articles, appearing in our issue of Sept. 15, 1892, there appeared a criticism of the practices then prevalent in the bestowal of engineering degrees written in Mr. Wellington's well known trenchant style. In order that we may not be again accused of tackling this question with lack of historical perspective, we reprint below Mr. Wellington's article of twenty years ago.

There is reason to believe that this article was influential in causing a number of colleges to drop the practice of granting the degree of Civil Engineer or Mechanical Engineer on completion of the four-year course. Mr. Wellington's strictures on master's degrees given for engineering courses are as pertinent today as when they were written, and we hope will receive the attention they deserve. Finally let us say that we are well aware of the difficulties met by many progressive men on the teaching staffs of our engineering schools in attempting to reform this matter of engineering degrees. Of all the strongholds of ultra-conservatism, education is probably the best intrenched. ENGINEERING NEWS is indeed "desirous of giving intelligent and sympathetic help," to quote Mr. Nelson's words, toward the introduction of needed reforms in matters of engineering education. And reform in engineering degrees is not an unimportant matter. Present practices in the granting of degrees lend point and force to such sweeping and widely circulated criticisms of higher education as those put forth by the late R. T. Crane.

THE DEGREES CONFERRED BY ENGINEERING SCHOOLS

By the late Arthur M. Wellington

There is a very general feeling among practicing engineers, with which we fully sympathize, that the conferring of a degree of "Civil Engineer" upon young fellows who have never had a day of responsible work to do as such is not only no aid to them but morally indefensible, for the simple reason that it is telling a lie, knowing it to be such, and "a lie is made no more respectable by being solemnly engrossed on parchment and certified to by the president and faculty," as we once remarked in discussing this question.

It is admitted that the arguments on the other side have a certain force, the chief argument being that it is not intended to deceive, but a well understood convention, similar to that by which the young medical student is declared to be "learned in medicine" as soon as he has begun to know a little about it by three years' study, some three months of which combines some practice with it.

But the analogy is hardly sound for this reason if for no other, that some sort of loud sounding degree is a needful help to the young physician seeking patients, while it is neither a necessity nor a help to the young engineer seeking engagements. Neither is it clear, even if the argument be admitted, how it is made any more respectable for professors of engineering to tell lies on parchment because professors of medicine do so.

A large majority of the colleges seem to feel the force of these objections in some degree at least. Only about one-third of the colleges, and a much smaller proportion of the strong and large colleges, confer the degrees of C. E., M. E., etc., upon their undergraduates. The practice of the 60 colleges tabulated in Table XX may be thus summarized:

Degrees conferred	Number of colleges
C. E., M. E., E. M., etc.	23
B. C. E., B. M. E., etc.	11
B. E.	4
B. S.	11
B. S. in C. E., M. E., etc.	9
Ph. B.	2
Total	60

Unfortunately, the apparent conclusion which these facts warrant is vitiated by the fact that all the colleges with a very few honorable exceptions (of which the Massachusetts Institute of Technology is one) have invented a method of whipping the devil around a stump so as to attain the same end, by a device which is certainly well calculated to tickle the sense of humor of any man who has any.

They will not call the mere undergraduate C. E.; not they; he does not know enough; but after he has had three months' to six months' to twelve months' experience in the field, or after he has taken another year or (in a few cases) two years of study under the college professors, then he knows enough! Then they can give him the degree of C. E. or M. E. with a perfectly clear conscience, and every last one of them does so with too few exceptions to speak of!

Not only so, but quite a number of them will for this amount of study or practice or a little more, go still farther and dub a man a Master of Civil Engineering (!), or at least a Doctor. Even the Massachusetts Institute of Technology, which we have spoken of as an honorable exception, is perhaps only a dishonorable one. It will not, indeed, attempt to dub a man a Civil Engineer at any time. It knows its limitations in that direction; but only for one extra year of post-graduate study, or five years in all, it will and does dub a man a Master of Science! Heavens; what a title for any man to bear and not be ashamed, even after a lifetime of study!

Lessons of the British Coal Strike

The strike of British coal miners, which began on Mar. 1, probably surpasses every other labor disturbance in modern times in the widespread extent of the injury done to commerce and industry. This injury means far more than merely temporary loss of profits by merchants and manufacturers and transportation companies. It has meant loss of employment to hundreds of thousands. In fact, it is estimated that when conditions were at their worst, two million men were thrown out of employment. In a country where the margin between daily earnings and the cost of the necessaries of life is so narrow as it is in England, this has meant that hundreds of thousands have literally been on the verge of starvation. The hard-earned savings of millions of people have been exhausted or seriously reduced by the period of enforced idleness. It will require the patient accumulation of months, and in many cases of years, to restore the savings which have been swept away by the distressing labor war of March, 1912.

These things appeal with special force to Americans, since a strike of coal miners in the United States has long been impending and at the present time over 400,000 American coal miners are idle. Fortunately, the indications are that the stoppage in the bituminous coal field will be of short duration, an agreement having been reached between the representatives of the miners and the mine operators under which the men are to return to work at an increased wage of 5c. per ton. In the anthracite field an agreement is not yet in sight, but a more conciliatory temper seems to prevail between the miners and the operators and it is hoped that this difficulty also may be settled at no distant day.

We have before this, in commenting on the English strike, referred to the fact that this strike and its serious consequences has been to thousands and millions an object lesson in the elements of economics.

In the face of the conditions which existed last month in England the old traditions and theories of the "Laissez Faire" school of economics have been swept aside. The concepts of Adam Smith and his followers do not at all fit the conditions which prevail in present-day industry. The doctrinaire in his study may theorize about the right of the workman to sell his skill and muscle to the highest bidder; but the million odd coal miners who struck last month for the principle of a minimum wage, knew that not one of them standing alone could hope for anything more than a starvation wage.

Even among ultra-conservatives today, therefore, the principle of "collective bargaining" is accepted. It is recognized that the individual workingman today can only meet the employer on anything like equal terms by combining with his fellows. Even then the bargaining is hardly on an equal basis, for the united employers can stop operation with no worse result than the loss of profits; but the workmen, if they stop work in the hope of making a better bargain, lose not merely profit but their means of subsistence.

Deplore, as one must, the frequent deadlocks between employers and workmen, which come about in the process of collective bargaining for the sale of labor, it must be recognized that the process is here to stay. If the position of employers and employees were reversed, the former would be as ready to combine together for mutual protection as are their present workmen.

We cannot stop strikes and deadlocks in industry, therefore, by preventing the

workmen from combining in labor unions. It would be impossible to enact a law to effect this in any country of the world today, and if it were enacted, it could not be enforced.

But the most profound lesson of the British coal strike has been its proof that the party which has the greatest interest at stake in any such industrial conflict is neither the employers nor their workmen, but the general public. There may be a hundred thousand who own shares in coal mines and a million workmen who mine coal; but there is a whole nation full of people who will freeze and starve if all coal mining comes to an end. And beyond the borders of the nation, the commerce and industry on which millions depend for a living is affected in greater or less degree.

How absolutely our whole civilization —commerce, industry, transportation and life itself—are all dependent upon the coal supply has been demonstrated by this great English coal strike as never before.* The only reason why universal paralysis of industry and starvation was not inaugurated in every city and town as soon as the coal mines ceased working was because the accumulated stores of fuel made the stoppage gradual instead of immediate.

While the general public is the party which has the greatest interest in these great industrial conflicts, we are only beginning to recognize this by legislation. Without discussing the pros and cons of compulsory arbitration laws, it must be recognized that the strongest force compelling an agreement between capital and labor is the force of general public opinion.

It must be recognized, also, that in any such agreement, the interests of the ultimate consumer ought to be recognized as surely as the interests of workmen and employers. When industry becomes so organized that all the labor and all the capital engaged in it acts as a unit, there may be agreements between capital and labor to raise the scale of wages, and this increased scale may throw an unjust burden on the purchasing public. In fact there is no room for doubt that one of the causes of the present high cost of living is that in many industries where strong labor unions exist, the reduction in hours of labor and increase in the wage rate has so increased the labor cost as to add materially to the final price which the purchaser must pay. While this situation is well understood by students of economics and is coming to be understood by the general public, legislation to protect the public against unfair exaction of this sort is still in the future. All that is attempted to be done at present in connection with labor deadlocks is to provide means for bringing the employers and employees to an agreement so that the industry may resume operation.

What is easily the most important feature of the English coal strike and what should be the most instructive is the method by which it was settled. Most Americans are aware that the settlement was brought about through the passage of a minimum-wage bill by Parliament, and there is a general impression abroad that this minimum wage act fixes wages in the coal-mining industry. The bill itself, however, does nothing of the sort. In fact, it was upon this point that Mr. Asquith, the British Prime Minister, stood firm against great pressure.

What the minimum-wage act does is, first, to divide the entire coal-mining industry of Great Britain into districts, the division being so made that conditions in each district as to character of the mines, method of working, difficulties of operation, nearness to market, etc., may be as nearly as possible uniform. The bill provides for 21 separate districts. In each of these districts there is to be organized a district board. Upon this board both employers and workmen are to be, "in the opinions of the Board of Trade fairly and adequately represented"; and the chairman of the board is to be "an independent person, appointed by agreement between the persons representing the workmen and those representing the employers." In default of such agreement, the chairman will be appointed by the Board of Trade. In case the employers and workmen do not come together in creating a joint district board in any district, within two weeks of the passage of the act, the Board of Trade may appoint any persons they see fit to act in the place of the joint district board.

Turning now to the powers and duties of the district board, the first section of the act is as follows:

(1) It shall be an implied term of every contract for the employment of a workman underground in a coal mine that the employer shall pay to that workman wages at not less than the minimum rate settled under this act and applicable to that workman, unless it is certified in manner provided by the district rules that the workman is a person excluded under the district rules from the operation of this provision, or that the workman has forfeited the right to wages at the minimum rate by reason of his failure to comply with the conditions with respect to the regularity and efficiency of the work to be performed by workmen laid down by those rules; and any agreement for the payment of wages in contravention of this provision shall be void.

For the purposes of this act, the expression "district rules" means rules made under the powers given by this act by the joint district board.

(2) The district rules shall provide, as respects the district to which they apply, for the exclusion from the right to wages at the minimum rate of aged and infirm workmen, and shall lay down conditions with respect to the regularity and efficiency of the work to be performed by the workmen, and provide that a workman shall forfeit the right to wages at the minimum rate if he does not comply with those conditions, except in cases where the failure to comply with the conditions is due to some cause over which he has no control.

It will be apparent from the above outline of the act that what is accomplished is not the fixing of wages by law, as has been by many erroneously supposed, but the creation of a means by which the employers and the workmen in each coal-mining district are brought together in a responsible and legally established organization which must establish the least rate of wages to be paid to workmen.

Under these conditions the act does not by any means end competition in the coal-mining industry or between the coal-mine workers. It will be necessary, for example, that some of the coal-mine districts, having the poorest coal and farthest from market, shall have a lower minimum wage rate than other districts more favorably situated; otherwise the coal trade will gravitate to the more favorably situated districts and the mines and miners in the poorer districts will have to lie idle.

While the act in this form was strongly opposed by the miners' representatives, who argued in urgent terms for the fixing in the bill itself of a minimum wage applicable to all England, it is difficult to see how under such a bill some of the mines in the poorer coal-mining districts could have been kept in operation.

It is well known, of course, that the British Government only enacted the minimum wage bill under the pressure of an impending national calamity of unprecedented proportions. Careful study of the bill shows that notwithstanding this, the bill has been drafted on conservative lines and is far less radical than would be supposed from the more or less superficial criticisms which have appeared.

It has been said that the adoption of minimum wages in the coal industry will be followed by strikes in other industries to secure similar enactments there. The law, however, does nothing more than to provide means whereby in an organized industry representatives of employers and employees can come together in conference and agree upon minimum rates of wages. This should accomplish much toward an amicable settlement of labor disputes and should lessen the chances of frequent nation-wide deadlocks between capital and labor with their dire consequences.

*The British coal strike is the greatest object lesson in conservation the world has ever had. Everybody knows that we are rapidly using up the stores of mineral fuel accumulated underground in past geologic ages and that the price of coal is certain to go on rising as the underground stores are reduced and become more difficult to obtain. Perhaps the most serious damage of all in connection with the English coal strike was that certain deep pits are said to have been drowned out by rising water during the suspension of operations, and the cost of their redrainage is so great that the remaining coal in them will be forever inaccessible.

The White River Power Development in Washington*

The Pacific Coast Power Co. has two other hydro-electric plants but practically without storage capacity; when greater capacity was demanded the new development was planned to take the load fluctuations of the whole system. A large lake has been created to impound the variable flow and the hydraulic works are designed for maximum economy of water. The White River carries large quantities of glacial silt and drift which had to be cared for at the diversion dam and settling basins.

*From data supplied by the Stone & Webster Engineering Corporation, 147 Milk St., Boston, Mass.

The White River development of the Pacific Coast Power Co. is located in the Puget Sound district of the State of Washington, some 25 miles southeast of Seattle and 10 miles east of Tacoma. It has recently been placed in operation and serves a double purpose; the two older water-power developments supplying this region, one on the Puyallup River and the other at Snoqualmie Falls, have an aggregate capacity of 35,000 kw., and not only has this capacity become outgrown, but also neither plant is so situated as to have the advantage of extensive storage. The White River development has now added outright 36,000 hp. to the generating capacity of the system, and has provided moreover an enormous storage capacity.

The White River rises in glaciers on the north and east slopes of Mt. Rainier and drains about 400 sq.mi. The minimum recorded flow at the point of diversion is 420 cu.ft. per second, with a low-water period of two months in the fall previous to the rainy season.

The scheme of development permits enormous storage, warranting an ultimate capacity of 100,000 hp. The headworks, flume, storage basins and canals have been built for this capacity, but the initial turbine installation is of 36,000 hp., with room for another 36,000 without change.

The point of diversion is near the town of Bulkley (Fig. 1), which is some 22 miles from Tacoma and seven miles southeast of Lake Tapps. There is a high plateau between the point of diversion and Lake Tapps, slightly shelving and extending westward with a series of comparatively small natural depressions which have been converted into storage basins and connected by flumes and canals.

Lake Tapps is two miles from the lower valley of the White River and 450 ft. above it, with a ridge 600 ft. high between the lake and valley. The natural level of the lake has been raised 35 ft. by dams and embankments and the flooded area has been increased from 600 to 3000 acres with an available storage of 2,225,000,000 cu.ft. The outlet canal extends from the northwestern arm of Lake Tapps to the western ridge of the plateau. A tunnel carries the water under the highest part of the ridge, and pipe lines lead down to the power house at Dieringer.

The number of men employed, the great quantities of material necessary and the wide extent of the work demanded careful preparation. There were thirteen camps established at one time, the principal one being at Dieringer, on the main line of the Northern Pacific R.R. The second important camp was at the headworks near Bulkley, on a branch line of the same railroad. From these two points all materials and supplies were distributed. At Camp 1, a standard-gage inclined cable railway was built to the top of the ridge and equipped with an electric hoist to take a loaded standard-gage car or locomotive up 3000 ft. of a 25% grade and in 12 or 15 minutes. This incline was of permanent construction with switchbacks and derailing switches, etc.; from the top, several miles of standard-gage track were built around the northern end of Lake Tapps to be used in the construction of embankments. This arrangement for getting standard-gage cars onto the work without reloading saved much time.

Among the auxiliary works was a sawmill having a capacity of 70,000 board feet per day, on the north shore of Lake Tapps. Ample timber supply was found on the heavily wooded shores of the lake.

HEADWORKS—The diversion dam (Figs. 2 and 3) was a special type for its function to preserve the level of the river bottom and protect it against washing out at the point of diversion. At flood stages the river carries heavy drift so that the dam has been made low and broad with a surface designed to pass drift without injury. It is a rock-filled crib on concrete foundations. The entire length of 352 ft. is a spillway capable of discharging 50,000 cu.ft. per second—twice the quantity of the greatest recorded freshet. In times of low water, flash boards will raise the level 7 ft.; these are easily removed and in case of sudden floods or heavy drift would be swept away automatically without damage to the permanent structure. The concrete foundations rest on impervious hardpan. Concrete wing walls extend up-stream on both sides of the dam, to prevent the stream from changing its course. The intake (Fig. 3) is of concrete with its opening perpendicular to the axis of the dam and parallel with the flow of the stream. A heavy boom protects it against floating débris and there are grooves for stop logs and headgates worked by a gasoline engine, or by hand; a sluiceway has been built to discharge small boulders and gravel from the intake.

A wood flume, 28 ft. wide, 8 ft. deep, sloping 7 ft. to a mile, carries water from the intake a mile to the first of the settling basins. The flume is built on 6x12-in. longitudinal mud sills 4 ft. apart, and cross sills (two 6x8-in. with 6x12-in. knee-braced side posts) on 4-ft. centers. The side posts are tied across the top with two 4x10-in. timbers and the flume is finished with 3x12-in. planks. In several cuts the mud sills lie on natural soil (hard clay conglomerate); the flume is carried about 2000 ft. on heavy pile trestle, which was afterward filled, though the weight of the flume was not carried on the fill.

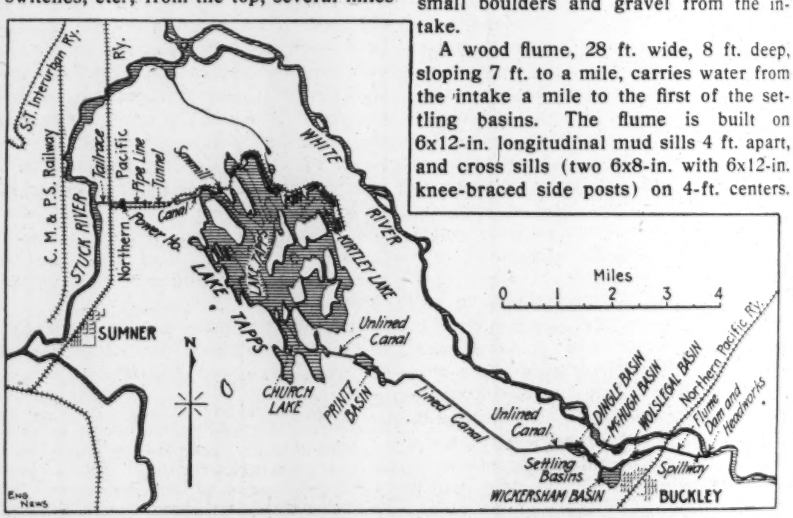


FIG. 1. MAP OF THE WHITE RIVER POWER DEVELOPMENT

FIG. 2. DIVERSION DAM UNDER CONSTRUCTION

SETTLING BASINS—A chain of settling basins about two miles long was made from four flat benches between a bluff on the south and a steep hillside on the north, which drops down toward the river. These benches are practically of uniform elevation and are separated by projecting points of land which have been cut by canals. Embankments along the northerly side completed the basins.

The first of the chain is long and narrow, admirably adapted to deposit all heavy silt before reaching its outlet. Sluice gates have been provided so that the basins may be drained and the silt sluiced out; they have also been provided with generous spillways to avoid being flooded above the intended level.

From the last basin an unlined canal about 7000 ft. long leads across a flat-top summit. The maximum cut is 35 ft. and the canal is 40 ft. wide at the bottom, sloping slightly under 1 ft. to the mile. As it is cut through a hard clay conglomerate and the section insures low velocity, there is no fear of erosion.

After crossing the summit this canal drops 111 ft. in two miles to a natural valley, and here the canal has been timber lined. To support the lining (Fig. 4), three rows of piles have been driven 8 ft. apart longitudinally, the middle row being cut off at the proper height to support mud sills which are spiked into gains in the outer rows. The inner surface of the outer rows has been faced to receive the side planks. True curves were used throughout on vertical and horizontal changes of grade. No wave action or disturbance of water has been experienced.

There is a drop of 94 ft. in the last 8500 ft. of this lined canal, where the water enters a natural valley, and here is opportunity for a secondary power development. Under 80-ft. effective head, 3500 hp. may be produced at the time of minimum flow and 7000 hp. for nine months each year. The chain of settling basins could be used as storage for 7000 hp. on daily peak loads continually through the year.

From the canal the water flows 3500 ft. through this valley until it reaches another valley extending at right angles.

FIG. 3. INTAKE AND SUBMERGED DAM

FIG. 4. LINED CANAL

The water has been led across the valley and is confined between two 1600-ft. embankments far enough apart to give low velocity and additional storage. Then it passes 2900 ft. through a wide cut on a slope of 5 ft. to the mile and discharges into the new Lake Tapps near the old Lake Church (Fig. 1).

STORAGE RESERVOIR—The Lake Tapps storage basin includes Kirtley, Church and Crawford Lakes. Numerous small ravines lead from this natural basin to the White River Valley and these have been closed by embankments. The topographical studies showed the economic limit for raising the level of the lake to be 35 ft. For higher levels, the cost of embankments would be all out of proportion to the benefits derived; sufficient storage for several years will be derived by filling the reservoir 29 ft. above the old level of the lake. Thirteen em-

bankments, totaling 600,000 cu.yd. were built by dumping from railway trestles the spoil of the outlet canal and tunnels noted below. The material was a cement clay puddled with gravel. Excavated material unsuitable for impounding water was wasted on the back sides of the finished embankments, adding weight and stability.

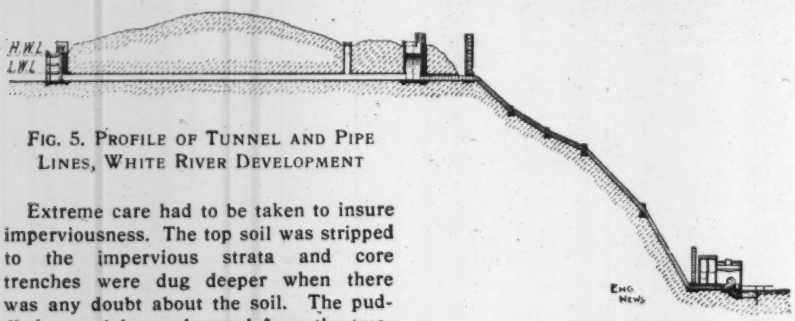


FIG. 5. PROFILE OF TUNNEL AND PIPE LINES, WHITE RIVER DEVELOPMENT

Extreme care had to be taken to insure imperviousness. The top soil was stripped to the impervious strata and core trenches were dug deeper when there was any doubt about the soil. The puddled material was dragged from the trestles into place by large scrapers and donkey engines, while the finishing was done with horse-drawn scrapers. The water sides were given a 2½-on-1 slope, the back sides a 2-on-1. The width of the embankment at the top was 40 ft. The engineering specifications for dimensions were generally exceeded because the spoil to be wasted was greater than needed.

OUTLET CANAL—At the northwestern corner of old Lake Tapps is a long, narrow indentation, at the northern end of which a coffer-dam was built to permit excavation of an outlet canal beyond. The coffer-dam was made heavy and permanent, with provision for stop logs in case it was desired to unwater the outlet.

This canal was the heaviest cut on the work, 600,000 cu.yd. being excavated in a length of 2500 ft.; the greatest depth was 90 ft. A bottom width of 45 ft. was kept throughout except at the western end, where 125 ft. was needed for 300 ft. to form a forebay in the front of the tunnel portal at the western ridge. The material excavated was a clay conglomerate which required blasting to loosen.

The maximum capacity of the canal is 3000 cu.ft. per sec. and a heavy rectangular covered timber conduit was laid in the bottom to prevent erosion. The sides and top are of 12-in. plank laid edgewise. The conduit has been anchored and back filled to a depth of 4 ft. to prevent possible floating. It is always submerged.

The tunnel (Fig. 5) through the western ridge is a smooth straight circular conduit 2850 ft. long which was worked from three headings simultaneously. The material was a hard clay for the whole length. It is lined with reinforced concrete and has an inside diameter of 12 ft. The minimum thickness of lining is 12 in., and the voids between lining and excavation were grouted full.

The entrance portal is of concrete with a bell mouth to reduce entrance head and to support the gate house and racks. The gate is electrically operated and has a by-pass; air shafts, in the gate house, prevent a vacuum when the gate is closed. The rack bars are of ⅜x5-in. iron and form a straight panel 58 ft. high by 40 ft. wide. The rack is provided with motor-operated cleaning devices.

The western end terminates in a circular forebay 30 ft. in diameter and 35 ft. high, located 250 ft. back from the western brow of the hill. The pipe line for each turbine starts at this forebay, smaller concrete-lined tunnels leading out to the brow of the hill. At the top of the forebay is a gate house and a spillway capable of discharging all possible surges here. The upper half of the pipe tunnels is oval-shaped and the lower half is circular, 9 ft. in diameter. An 8-ft. pipe is drawn into each tunnel and connected to an 8-ft. gate valve concreted in the forebay lining. The oval-tunnel section leaves room for inspection of the pipe.

Ultimately, there will be six pipe lines and tunnels, three connected with a similar forebay not yet built. At the outlet of the tunnels the steel-pipe lines are connected with a header from which the small exciter pipe leads. The exciter line can thus be supplied from any of the main lines.

From the tunnel portals the pipe lines follow the hillside contour for some 2000 ft. They were laid in back-filled trenches, with concrete anchors. The diameter of the pipe line varies from 8 ft. above to 6 ft. below and varies in thickness from ⅜ to 1⅛ in. The circular seams are double-riveted and the longitudinal seams have a double-strap triple-riveted butt joint.

Multiple provisions have been made against surges in the long column of water. There is first an open standpipe 6 ft. in diameter, 85 ft. high, at the upper end of each pipe line. The top of these is 25 ft. above high water. At the lower end of each line, and outside the power house, are two air chambers 7 ft. in diameter and 75 ft. high, containing 2000 cu.ft. of air under 190 lb. pressure maintained by the hydraulic head. This air cushions the water column for each unit independently and permits governing without waste. These cushion tanks are fitted with floats and valves to allow free water passage in and out, but to prevent escape of air into the pipe line. As a third measure, each turbine casing is connected to two 30-in. relief valves, one operated by the governor and the other operated by pressure rise. Bursting plates have been inserted in a separate discharge pipe, to give way in case the valves should fail.

POWER STATION—The reinforced-concrete building covers an area 204x82 ft. parallel with the base of the hill. Back of the main generating room on the front of the building, is a switch house 200x35 ft. and three stories high, each story being partitioned to suit the various purposes. On the lower floor, in cells opening into the generator room and separated from the later by fire doors, are the step-up transformers between the generators and transmission lines. Similar cells, facing

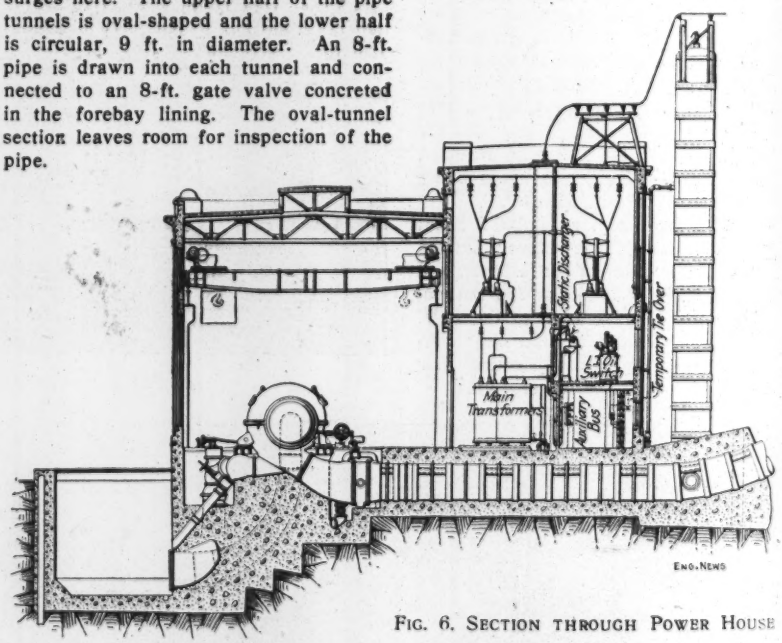


FIG. 6. SECTION THROUGH POWER HOUSE

the generator room, contain the local lighting transformers and the exciting sets. The low-tension alternating-current busses are behind with a partition between. On the second floor is the operating room and switchboard, the front of the room being built on a curve overlooking and overhanging the generator floor. At each end of the operating room is a gallery reached from the generator floor by iron stairs. Here are the private offices and toilets, and in back are the low-tension oil switches and static dischargers. On the second floor is a small storage battery for the oil switches and emergency lighting. The top floor of the switch house contains the high-tension oil switches and bus bars. On the roof is a steel structure for holding the transmission lines, the leads to which come up through roof insulators from the room below.

The design and construction of the hydraulic equipment will be described in a subsequent article, so that it is sufficient here merely to mention that the main turbines are a double-discharge single-runner high-head Francis type normally rated at 18,000 hp., but capable of developing 20,400 hp. under increased head. The wheel cases are of cast steel; the bearings are a water-cooled, oil-ring type; water-cooled friction brakes have been provided for quick stops. The guaranteed efficiency is 84½%. Only two wheels have been installed, but the present building has room for two more; the ultimate installation of six will require an extension. The main generators are a 10,000-kw. 6600-volt three-phase type showing factory tests of 96.8% efficiency. Two 720-hp. 400-r.p.m. impulse-wheel exciter units have been installed, with 225-kw. 240-volt direct-current generators. Provision has been made on the base-plate of the impulse wheels for driving by induction motors if considered advisable later. The step-up transformers have 3330 kw. capacity, are oil-insulated and water-cooled. The current from the generators is stepped up to 55,000 volts for transmission. For local lighting and power three 200-kw. 6600/23,000-volt transformers have been provided, and six 75-kw. 6600/220 and 110-volt.

The main switchboard is 24 ft. long and controls the motor-operated head gates, generators, step-up transformers, bus connections and transmission lines. At the left of the main board are the exciter panels and at the right the local-service control. The high-tension busses are of iron pipe covered with copper paint. Static discharge devices have been provided in the power house for the 6600-volt system; for the high-tension line aluminum-cell lightning arresters have been installed in a small building outside.

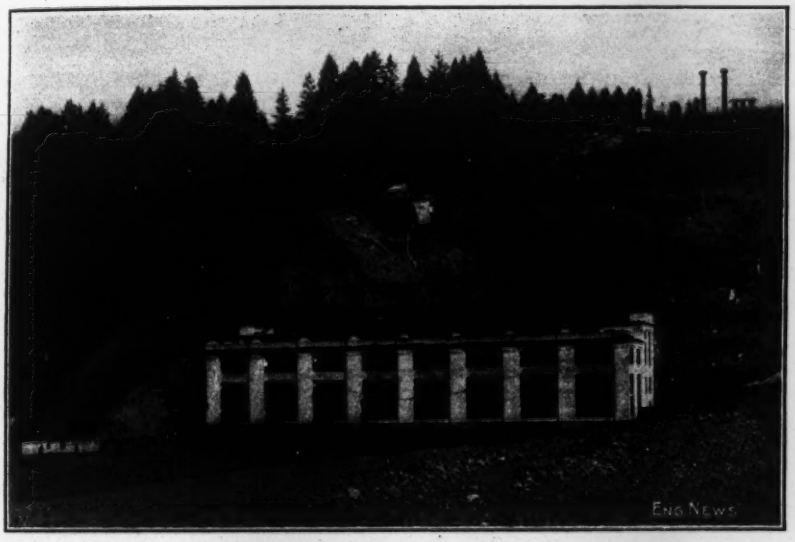


FIG. 7. VIEW OF POWER HOUSE, PIPE LINES AND HEAD GATES, DIERINGER, WASH.

There is a 550-cu.ft. motor-driven air compressor for charging the air-cushion tanks and for general station use. The central governor-oil system has motor-driven pumps.

TRANSMISSION LINES—This station is near the geographical center of the present transmission systems, so that long lines were not needed. There are eight lines in all leaving the station, four going north, two south, and two leading to the Seattle and Tacoma company's lines near the station. These lines are carried on steel towers 52 ft. high, having an average span of 400 ft. Each tower supports two duplicate lines of 0000 standard copper on four-piece pin-type porcelain insulators.

TAIL RACE—The tail bay is shaped for easy entrance to the race, the latter extending 2000 ft. west of the power house to the river. At the entrance to the race, provision is made for stop logs to form a weir for measuring wheel discharge. The race is excavated in low marsh and peat land and double rows of piling hold the banks. The section is wide for low velocity.

The entire development was planned and built by the Stone & Webster Engineering Corporation, of Boston, Mass.

A 1,000,000-lb. Dynamometer Car, recently placed in service by the Atchison, Topeka & Santa Fé Ry., is described in the April issue of the "American Engineer." Tht underframe, side and roof frame are entirely of steel, the underframe having a built-up box girder for the center sill. The length over end sills is 50 ft., and the extreme width is 10 ft. A length of 25 ft. at one end of the car is occupied by the dynamometer, recording apparatus, switchboard, gage board, work benches, stove and desk. The rear half of the car contains four upper and lower berths, a toilet room, closet and kitchen.

The dynamometer is of the double-diaphragm type, recording both draw-bar pull and draw-bar push. A pair of lever arms connected at one end to the draw-bar yoke transmits the forces with a reduction of 5 to 1 to a double-ended piston 20 in. in diameter, each end of which presses against one of the rubber diaphragms covering the liquid chambers. The piston is suspended from knife edges. Each liquid chamber contains a mixture of glycerin and alcohol and communicates with the recording apparatus and gages through ¾-in. copper pipes. When the dynamometer is not to be used the lever arms are brought to the mid-position and held there by four small jacks. The dynamometer is designed to safely take and record a force of 1,000,000 lb. at the draw-bar.

The pressures from the dynamometer are transmitted to standard steam-engine indicators on one side of the recording table, and in this way a record of the draw-bar push or pull is made on a chart 15 in. wide, which is drawn over the table between two friction rollers driven by an electric motor. Or if desired, the chart can be driven by a train of gears from the axle of an auxiliary truck arranged to be raised or lowered from contact with the rails.

A curve representing the speed is obtained by means of a Boyer speed recorder located in the base of the recording apparatus and driven by a chain from the main shaft. The time record is drawn on one edge of the chart by means of a pen actuated by a small electromagnet, which in turn is operated by an electric clock so as to make dots at intervals of one minute, five seconds, or one-half second as desired. The record of location of mile posts, stations, etc., is made by means of a small electromagnet-driven pen in connection with a push button in the observation cupola. The cupola is provided with an electric searchlight for night work. Records of throttle opening, reverse lever positions and other locomotive records are made similarly by means of electromagnets. There are also two steam-engine indicators arranged to give a continuous curve of air pressure in the air-brake cylinders and in the train line.

A Radical Innovation in Street Car Design*

Within the last few weeks, a new type of street car has been placed in experimental service by the New York Railways Co., which has assumed control of the old Metropolitan company's lines in New York City under the reorganization plans. The car is the joint invention of Frank Hedley, Vice-President and General Manager, and J. A. Doyle, Superintendent of Car Equipment. They hold also similar office in the Interborough Rapid Transit Co., which operates the present subway, and their invention shows the effect of subway experience. Indeed it may be called a development of the present subway car for surface conditions.

The most apparent advantage of the new design probably is the ease with which a passenger can enter or alight, the floor being only 10 in. above the ground. In the familiar type of surface car (which we may regard as a development of the earlier horse-drawn vehicle) the floor has been raised higher and higher by the demand for greater power and consequently more room for the motors. It has been possible to drop the floor in this new car by placing the trucks at the extreme ends of the car and the motors at the outer ends of the trucks. The floor extends, at the car ends, between the truck side frames which, with the wheels, project up under the end seats.

The car is of ordinary dimensions, 40 ft. 8 in. long and 8 ft. 3 in. wide; the truck centers are 29 ft. apart. Steel construction is used throughout except for the floor, window posts, head lining and roof. The bottom framing is of steel angles reinforced in the center of the car by two smaller angles in channel form. The end sills, from the bolsters out, are formed by two Z-bars bent down at the ends to receive anti-climbing buffers. The crossings are channels, placed back to back; the stringers are short angle sections riveted between crossings. Bolsters are built up of two angles riveted together, secured to the side sills with gusset plates, and are bent U-shaped, to accommodate the floor at the ends, the drop being 19 in.

The sides are framed as a truss, the top and sill angles being connected with steel posts at the end bulkheads, and center doors, and stiffened by the steel sheathing with its reinforcing bars and angles. The body without electrical equipment weighs 13,740 lb.

Difficulty was involved in providing for movement of the trucks under the body and still keeping the seats approximately on the same level. A modified maximum-traction type of truck was found best suited and was redesigned for low-truck bolsters. Clearance is made for maximum swing on a 40-ft.-radius curve by housings under the last transverse seats, which are made a trifle longer than the others. The narrow floor extension at each end is surrounded by a semi-circular seat. The floor here is a ¼-in. plate supported on the body bolster, which is depressed for this purpose. Thus the floor at the car end is directly over the truck bolster and between the side frames with the semicircular seats housing side frames and bearing plates. The semi-circular seats were necessarily about 6 in. above the other seats to obtain clearance for the trucks and the car floor is inclined to give the proper distance between seat and floor.

There are seats for 51 passengers and standing room for 30 more. Except for the semicircular end seats and the folding single seats at the doors, these seats are all transverse. The transverse seats, except at the end, have reversible backs and white-enameled grab handles. The conductor is stationed at the center opposite the door in service and he receives fares as passengers enter. With the floor close to the pavement, no grab handles are needed at the doors and the conductor does not assist alighting or boarding passengers.

The doors are double and engine-

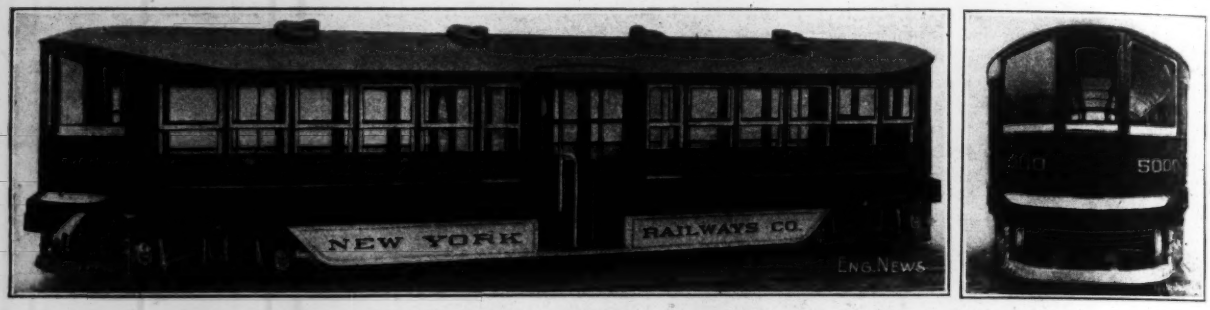


FIG. 1. A NEW TYPE OF STREET CAR
(Built for the New York Railways Co. by the J. G. Brill Co., Philadelphia.)

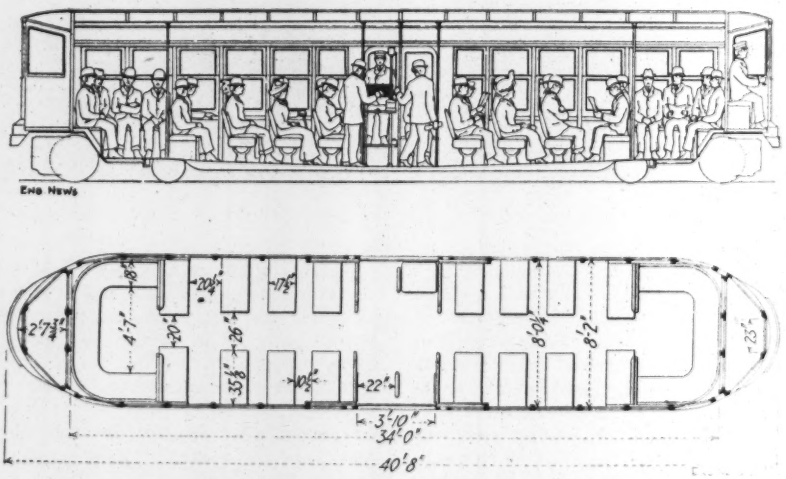


FIG. 2. SECTIONAL ELEVATION AND FLOOR PLAN OF THE HEDLEY-DOYLE "STEPLESS CAR

operated by compressed air. A pipe-and-plate stanchion divides the opening into two passages—an idea which has been found to facilitate loading and unloading in the subway cars.

The side windows have stationary upper sashes, but the lower sashes can be raised. All side sashes are removable for summer; sashes in the bulkheads and cab doors drop into pockets. The side-

*From data supplied by the J. G. Brill Co., Philadelphia, Penn.

window openings are guarded by heavy screening. The ends have, in plan, a sharp contour, to give glancing rather than direct blows in traffic jams or accidents.

The motormen's cabs are in the extreme ends and separated from the main interior by glass windows and bulkheads. The floors here are about level with the semi-circular end seats. In each cab is a seat, a straight-air brake valve, and a controller; under the seat in one cab is the air compressor. Access to the cab is by a front-end door.

Fresh air is electrically heated and admitted at the bottom of the car, a third of the heat necessary in cold weather

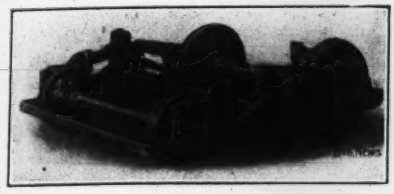


FIG. 3. MAXIMUM TRACTION TRUCK WITH LOW BOLSTER

being obtained from the control resistances. Ventilation is by natural draft up the roof ventilators, air admission being regulated by dampers connected to the truck springs and varying the amount of air admitted in accordance with the load carried. The floor is composition covered, permitting washing down, the water draining to a trap in the center.

The sample car shown here was built by J. G. Brill Co., of Philadelphia, on a rush order and was completed within one week. The arrangement has been patented by the designers.

New Subway Routes and Progress of Subway Construction in New York City

Three new rapid-transit routes have been adopted during the past week by the New York Public Service Commission for the First District. These routes will form a part of the comprehensive dual system of rapid-transit extensions which the Commission has already approved and which is now pending before the Board of Estimate and Apportionment. The new routes are known as No. 35, No. 38 and No. 33, respectively.

No. 35 is the Steinway Tunnel-Times Square extension. It begins at a point under 42d St., near Fifth Ave., at the westerly terminus of the present Steinway Tunnel route and extends westerly under 42d St. to the easterly side of Eighth Ave.

No. 38 is the Seventh Ave. extension and Varick St. route. It begins at a point under Seventh Ave. near West 12th St. and extends southward under Seventh Ave. and the proposed extension of Seventh Ave. and under Varick St. and its proposed extension to West Broadway and Leonard St. This route will connect at each end with the existing Seventh and Eighth Ave. route and is designed to make possible the building of the proposed extension of the present subway from Times Square down the west side of Manhattan, connecting near the Battery with the new tunnel to Brooklyn.

No. 33 is the Whitehall St.-East River-Montague St. route. It begins in Morris St., Manhattan, near the intersection of Greenwich St.-Trinity Place and Morris St., where it may connect with the Broadway-Lexington Ave. subway or the Seventh Ave. extension of the present subway. It runs under private property and Broadway to Whitehall St.; under Whitehall St. to the East River; under the East River to Montague St., Brooklyn, and under Montague St. to a point at or near Court St., where connections may be made with the other lines of the dual system.

PROGRESS IN CONSTRUCTION

A report made by the engineering department of the Public Service Commission for the month ending Mar. 15, 1912, gives detailed information of the progress in the construction on subways for which the contracts have already been let.

Broadway-Lexington Ave. Subway—There are now under contract and in actual construction 10 out of the 16 sections of the Broadway-Lexington Ave. subway and a force of more than 1300 men is employed by the various contractors. Work is going on at the following places: On Broadway between Park Place and Bleecker St.; on Lexington Ave. between 26th St. and 40th St.; on Lexington Ave. between 53d St. and 129th St., in Manhattan; and under Mott Ave. and other streets, Franz Sidel Park and various private properties from 135th St. to 157th St., in the Bronx.

Fourth Ave. Subway, Brooklyn—The work on this subway is about 85% completed. Work was begun in November, 1909. This is a four-track subway with additional tracks in places to provide connections for future extensions. The route extends from the Brooklyn end of the Manhattan bridge at Nassau St. through the Flatbush Ave. extension, Fulton St., Ashland Place and Fourth Ave. to 43d St., a total distance of about four miles. There are six sections under construction at an aggregate price of $14,807,222.

For a considerable proportion of its length, this subway is of uncommon size and depth. On this account and because excavation is all in soft material, some unavoidable damage has been done to buildings along the line. In Fulton St. and Ashland Place the subway passes under private property, the necessary rights having been acquired by legal proceedings. In Fulton St. the roof of the subway will be strong enough to support buildings when they are restored overhead, but in Ashland Place the street is to be made wider by taking a strip along the west side. The original parkway down the middle of Fourth Ave., which occupies a strip 20 ft. wide, will not be restored, being replaced by a narrow line of ventilating openings. The effect will be to widen the Fourth Ave. roadways correspondingly.

At Flatbush Ave. the new subway passes under the existing subway. At this point the reinforced-concrete walls of the new subway have just been completed and the existing subway now rests on its roof. Some settlement has occurred at one end of the Atlantic Ave. station of the existing subway, but it was not very great and caused no serious damage. No further settlement is anticipated.

Section 5 in Fourth Ave. from 10th St. to 27th St., is the most advanced of all, being about 98% completed, the only work remaining to be done is the repaving of Fourth Ave. from 18th St. to 27th St., and the completion of the interior finish of the 25th St. station. The report states that the contractor on this section made rapid progress by utilizing collapsible steel forms, by means of which he built the sides and roof of the subway, in sections 80 ft. long, over all four tracks at once.

Brooklyn Loop Subway, Manhattan—This subway runs from Park Row and Chambers St. north through Centre St. and the Delancy St. extension to the Williamsburg Bridge, with a spur at Canal St. connecting with the Manhattan Bridge. This subway has been completed for some time with the exception of section 9-0-1, extending from Chambers St. to Pearl St. The work on this section has been delayed by the erection of the Municipal Building, which will have one station of this subway in its basement. About 38% of the work on this remaining section had been completed at the end of February, 1912.

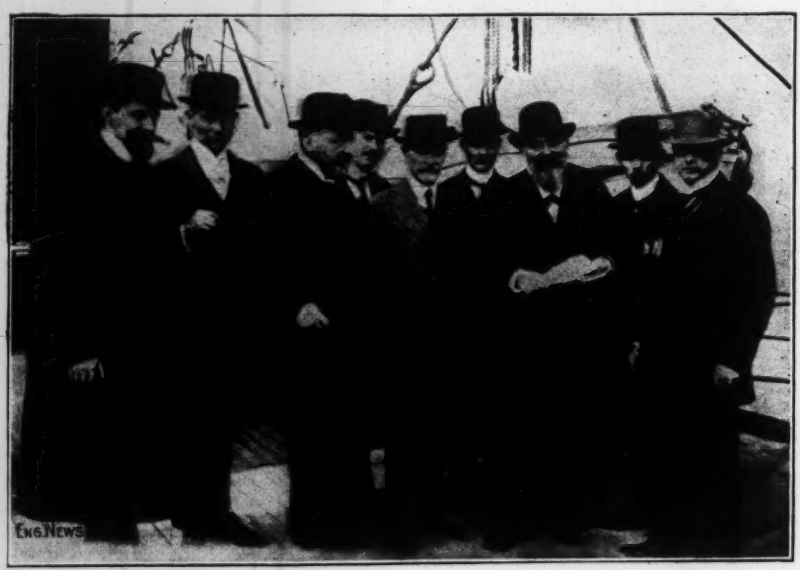
A Mercury Arc Rectifier for heavy service has been announced by Mr. Peter Cooper Hewitt, inventor of the mercury-arc lamp. This design of converter of alternating to direct current is particularly for railway supply, and resembles the earlier types, which have been limited to currents of under 50 amp. The new rectifiers are reported to have a capacity of 700 amp., with a possibility of raising these figures eventually. Details of construction are lacking, but it is stated that in place of the usual positive electrodes at the top of the vacuum tube (small wires sealed into the glass) there are metallic structures which support heavy positive electrodes in porcelain bushings. The rectifier is to be artificially cooled. It is reported that one such rectifier has been operated at East Pittsburg for a month at 200-kw. capacity, remaining in perfect condition.

Visit of the Bavarian Technical Museum Commission to the United States

The members of the Technical Commission in charge of the Museum of Science and Art at Munich, whose visit to the United States was announced on p. 650 of our last issue, arrived in New York on the "Amerika," on Saturday, Apr. 6. Their reception and entertainment in the United States is in charge of a committee of the American Society of Mechanical Engineers, of which Col. E. D. Meier, Past-President of the Society, is chairman.

On Sunday evening, Apr. 7, the members of the commission were the guests of Col. Meier at a supper given at the studio of William Schevill, in New York City, at which were present also a number of prominent New York engineers. On Tuesday evening a dinner was given at the Engineers' Club, at which the members of the commission were guests, and after the dinner, Dr. von Miller delivered a lecture in the auditorium of the Engineering Societies' Building, explaining the plan of the Museum. It is an institution of international scope. It aims to exhibit the most important inventions, tools and machines in all departments of science and industry.

The itinerary of the commission's tour as at present arranged includes visits to Washington, Pittsburg, Chicago, Detroit, Niagara Falls and Boston.



THE MEMBERS OF THE BAVARIAN TECHNICAL MUSEUM COMMISSION

(From a photograph taken on board the "Amerika" on arrival, reproduced by courtesy of the New York "Staats Zeitung.")

Reading from left to right: Mr. Orth, Civil Engineer; Dr. Ross, Secretary of the Commission; Dr. von Borscht, Mayor of Munich, Privy Councillor; Dr. Fuchs, Civil Engineer; Count von Podewils-Durniz, President of the Museum, former Prime Minister of Bavaria; Mr. Trautwein, Civil Engineer; Dr. Oscar von Miller, President of the German Society of Engineers and Professor in the Munich Polytechnic; Mr. Gelius, Architect to the Commission; Prof. Dr. von Dyck, Rector emeritus, Technical University of Munich.

Annual Meeting of the Lake Michigan Sanitary Association

This association (which is composed of health and other public officials, physicians, engineers and sanitarians) represents the states, municipalities, health boards, etc., interested in the use and protection of Lake Michigan as a source of public water supply. Its fifth annual meeting was held Apr. 4, at the University Club, Hammond, Ind. The technical part of the proceedings was preceded by a lunch, presided over by Dr. Wm. D. Weis, Health Commissioner of Hammond, and the retiring president of the association.

The election of officers resulted as follows: President, A. J. Horlick, mayor of Racine, Wis.; Vice-Presidents, Dr. Geo. B. Young, Commissioner of Health, Chicago, and Dr. Fred A. Tucker, President of the Indiana State Board of Health; secretary, W. R. Humphrey, Association of Commerce, Chicago. The papers and addresses dealt with two subjects: 1, preventive medicine and methods; 2, the sanitary problem of the Calumet district. One paper, however, dealt with the sanitary problem of the district north of Chicago.

PREVENTIVE MEDICINE AND METHODS

This general subject was dealt with by four speakers, and was opened by Dr. Geo. B. Young, Health Commissioner of Chicago, with a paper on "The Economic Value of Preventive Medicine." This discussed the relation of health and sanitation to the public at large and to industrial interests, and presented the view (which is not so universally recognized as it should be) that the maintenance of public health is of much greater economic importance than the cure of diseases and ills. In a discussion of the paper, Dr. F. A. Tucker, President of the Indiana State Board of Health, pointed out that political interference with or control of health boards necessarily prevents the attainment of their object. Physicians are only beginning to realize their relation to the matter of public health, and to understand that the highest value of their work is in the prevention rather than the cure of disease.

In a very interesting (but very brief) address on the subject of "A Big Business Proposition," Dr. John N. Hurty (Secretary of the Indiana State Board of Health) presented the business or commercial side of hygiene. He prefaced his remarks by showing that "business" never made inventions and discoveries in the field of general advancement; neither does it encourage or support the inventions and discoveries of scientists and others (who are animated by love of their work and not by desire for gain) until these can be shown to have a financial value. He presented a number of instances in different branches of science, and then made the application that this obtains in the field of hygiene. Physicians and sanitarians have made important discoveries in the control and prevention of diseases, and have shown conclusively that the underlying principle of this development is prevention, as opposed to cure. But little heed was given by "business" to the development of hygiene until it began to be realized that the health and welfare of the man had a distinct bearing upon his value to his employer, regarding the man simply as a machine. Typhoid, cholera, yellow fever, smallpox and consumption are no longer regarded as inevitable and unpreventable; hygiene can prevent these and many other diseases, as well as (to a large extent) insanity, feeble-mindedness and crime.

The same idea was followed out in an admirable address by Dr. W. A. Evans (formerly Health Commissioner of Chicago), who discussed particularly the relations between health and efficiency. Health boards have been preaching that the sanitary conditions of the shop and the home affect the efficiency of the workman and his value to his employer, and the employers of labor are gradually realizing the truth of this proposition. In the army, the health of the men is watched closely, and as a result of this the army has now a greater proportion of men of "100% efficiency" than it had ten years ago. But no employer of an army of labor has ever undertaken any such study, and many continue to employ men

who have little real economic value. At the Panama Canal, one of the best investments was that in relation to health, an important result being to demonstrate that under such conditions men of Anglo-Saxon race can work even in the tropics with a high degree of personal efficiency.

Turning from this general view to a practical application, he reviewed the remarkable growth of the region at the southeast corner of Lake Michigan as a great industrial district, which, in his opinion, is destined to be included eventually in a great Chicago "metropolitan district" extending in a 50-mile radius from the city proper. If this development is to have its proper value, there must be concerted action for town planning on modern ideas in this district, so as to offer to the workman the advantages of good houses at reasonable rates, good water, sewerage, schools, parks and conditions conducing to the health, comfort and welfare of himself and his family. Without such provision, the district will have but a stunted growth. People are already beginning to look for these conditions and to shun places where they do not obtain, and employers will soon begin to consider the health and efficiency of their employees.

The Sanitary Problem of the Calumet Region

The papers under this head related to the practical side of the development discussed in a general way by Dr. Evans. Until a very few years ago, a large part of this region was largely a wilderness, practically uninhabited, but with the establishment of many manufacturing plants of great size there has been a sudden development; new towns have been built and older ones in the vicinity have grown. The development has been haphazard, however, with no concerted action between the various municipalities and other interests; the result has been that the pollution of the lake by sewage and industrial wastes renders it dangerous as a source of water supply. In a paper on "The Solution of the Calumet Problem," Prof. R. L. Sackett (of Purdue University) pointed out that there are three phases of the sanitary problem: 1, protection of water supply; 2, surface or land drainage; 3, sewage disposal. After noting different plans that have been proposed he showed that his solution of the problem is treatment or sterilization of the sewage, followed by discharge into the Sag Canal, which will carry it to the Chicago drainage canal. Sterilized sewage should under no circumstances be discharged into the lake. To carry out any such plan will necessitate putting it into the hands of one public authority, but the difficulty of this is increased by the fact that it is an interstate problem, including both Illinois and Indiana.

In the discussion on this paper, Dr. H. E. Barnard (Indiana Food and Drug Commission) referred to the water surveys which have been made to determine the conditions of pollution of the lake and the relations of the sewer outlets to the water intakes. He referred also to the project for the establishment of a Calumet Drainage District, to include the areas in both states. Mr. Langdon Pearse (Assistant Engineer, Sanitary District of Chicago) spoke of the existing conditions of the Calumet region as a disgrace to any civilized community, the water intake of one municipality taking sewage discharged from the sewer outlets of another, to say nothing of the added pollution by industrial wastes. He described the relation of these sources of pollution to the water supply of several towns in the district. The Sanitary District of Chicago is interested only in the question of sewage disposal; its work on the Sag Canal is undertaken purely with this view, and as it will be ready for the water by 1916 a start should be made very soon in deciding upon some comprehensive scheme of water supply, sewerage and drainage. John W. Alvord (Consulting Engineer, Chicago) spoke of his present work in investigating the sewage-disposal problem for an area of 25 sq.miles around the city of Gary, Ind. As to the Sag Canal, disposal of the sewage by dilution alone is impracticable, as the main drainage canal could not carry the enormous amount of water required; therefore, some preliminary treatment is a necessity. The only way of arriving at a solution of the problem is to establish a sanitary district covering the entire territory, regardless of state or other artificial boundaries.

The North Shore Sanitary Problem

In this paper, James O. Heyworth (President of the North Shore Sanitary Association) discussed the problem of the district lying north of Chicago and including a number of residential towns. Here, the sewage is discharged into the lake, to pollute the water supply of the city of Chicago. As a result of the conditions, a survey of the water pollution was recommended. The North Shore Sanitary Association was formed, and money to pay for the investigation was raised by subscription. A review of the results was published in ENGINEERING NEWS of Sept. 29, 1910. As the associationtion had no power or legal authority, it promoted and secured the passage of a bill authorizing the establishment (by petition) of a drainage district "whenever any area of contiguous territory within the limits of a single county shall contain two or more incorporated cities, towns or villages, and shall be so situated that some form of sewage disposal will conduce to public health." The value of such an incorporated sanitary district to the community is that its trustees have power to provide for the disposal of the sewage and to preserve its water supply from contamination. It may issue bonds, not exceeding 5% on the valuation of the taxable property in the district.

The cost of intercepting sewers extending along the shore from Waukegan to Wilmette was estimated by Mr. Heyworth at less than $1,000,000, with $500,000 additional for a purification plant to treat the sewage preliminary to its discharge. This cost includes the necessary pumping plants. The ultimate discharge would be into the head of the North Shore channel of the Chicago drainage canal, at Wilmette. This channel was described in our issue of Jan. 5, 1911; and in our issue of Dec. 14, 1911, we noted that the Sanitary District of Chicago has proposed to build intercepting sewers to connect the several towns with this channel, when they provide for sewer systems in connection with these interceptors. This action was taken for the reason that the towns cannot afford to build the works necessary to discharge their sewage into this channel.

Mr. Heyworth laid stress upon the idea that the problem is not a difficult one. The trouble lies not in providing a solution, but in getting the public interested and thus obtaining a public sentiment or opinion to back the project for an improvement. The first work in all such cases must be done by a few men who have enough public spirit and enough foresight to push the matter without thought of personal benefit and regardless of both opposition and indifference.

The Worm Which Eats Steel Rails—This terrible insect, after hibernating on the shelf of some newspaper editor's repository of Munchausen tales for 22 years, has been brought forth to the light and has resumed his career of destruction. Evidently he is as long-lived as the newspaper jokes and, like them, reappears every once in so often to test the gullibility of a new generation of readers.

According to a "special cable dispatch" to the Chicago "Record-Herald" and the New York "Herald," dated Rome, Feb. 3, Italian engineers are given the honor of discovering in steel rails "numberless worm-shaped creatures, a dirty gray in color and about one-third of an inch long."

This description corresponds very closely with a similar newspaper story of a "discovery" some twenty-odd years ago by German engineers, which was reprinted in Engineering News of May 10, 1890. In commenting on this story we then said: "The following venerable chestnut is still traveling about through the press. We have noticed it once before as a curious illustration of the gullibility of man."

The veracious chronicler at that time declared: "There is no exaggeration in the assertion that this creature is one of the most voracious, for it has devoured 36 kilograms of rails in a fortnight."

After a 22 years' fast it doubtless has a still more alarming appetite. We expect soon to hear that it is being cultivated by the Steel Trust to increase the market for its products!

Notes from Engineering Schools

UNIVERSITY OF ILLINOIS—The second competition for the Francis J. Plym fellowship in architecture is announced. This fellowship provides $1000 for one year of European travel and study. The competition will be held in April and May and will be open to all graduates of the Department of Architecture of the University, under 30 years of age. The competition consists of a preliminary and final exercise in architectural design. The preliminary work consists of a problem to be executed in three days, the work to be done locally under approved supervision. The best four designs will be selected for the final exercise, which will consist of a more extensive problem to be executed within about five weeks. The best design will carry the appointment of the fellowship. The winner must sail for Europe before Sept. 1, 1912, and must remain abroad for the study of architecture for one year; he must not accept remunerative employment during that time. Persons wishing to compete should notify Prof. F. M. Mann, University of Illinois, Urbana, Ill.

UNIVERSITY OF WISCONSIN — A new form of examination is being given by Prof. R. H. Whitbeck, of the Geology Department, following a recent suggestion for testing the knowledge of students. The idea has been applied to examinations in physiography. A list of statements concerning geographical subjects, part of which are true and part of which are false, is submitted to the student. He is required to mark the statements which are false. A positive knowledge of the principles or facts involved is required to detect the false from the true.

A Boiler Explosion at Salisbury, Md., Apr. 5, at the plant of the Crystal Ice Co., caused the death of two men and seriously injured one other. The ice-making plant was almost completely demolished. The explosion occurred at about 7:20 a.m.

A 656-ft. Steel Tower Collapsed, Mar. 30, at Nauen, Germany, during a severe storm. The tower was used for a wireless telegraph station and had recently been doubled in height. It is claimed that this was the highest steel skeleton tower in the world with the exception of the Eiffel Tower, in Paris.

Floods on the Mississippi River reached unprecedented heights during the past week and caused widespread damage and some loss of life. Very high, though not record, floods in the Ohio and its tributaries combined with similar high water in the Missouri and the other western tributaries of the Mississippi to cause the record stages in the latter river from Cairo south. The crest of the flood was at Cairo, on Apr. 6, when a gage of 54 ft., or 1.7 ft. above the record, was reached. On Apr. 7 it reached Memphis, with a stage of 45.5 ft., or 8.4 ft. above the record. On Apr. 10 the crest was approaching Vicksburg. A number of breaks in levees have been reported. At Hickman, Ky., on Apr. 2, levees on both sides of the river broke, flooding enormous areas of land and overwhelming the city. The break on the east bank allowed an overflow into the Reelfoot Lake district and thence southward through several Tennessee river counties, flooding some 500 sq.mi. of territory. On Apr. 6 breaks occurred at Wyanoke Landing, Ark., and St. Clair, Ark., seven miles below and nine miles above Memphis, respectively, and on the Atchafalaya River, near Baton Rouge, La. On Apr. 9 a break occurred at Golden Lake, Ark., 50 miles north of Memphis. South of Memphis three counties of Arkansas were under water on Apr. 10.

Grade-crossing Accidents in New York State, according to the report recently issued by the National Highways Protective Society, decreased during the first quarter of 1912. During this period covered by this report, 12 persons were killed and 12 others injured in New York, as compared with 25 killed and 25 injured in the corresponding quarter of 1911.

In New Jersey, during the first quarter of 1912, 18 persons were killed and 11 others injured, as compared with only two killed and five injured in the corresponding period of 1911.

A Grade-Crossing Accident Verdict awards damages of $2500 for the death of one of the five persons killed in a one-horse carriage on the Trotting Course Lane crossing of the Long Island R.R., July 2, 1911, near Glendale, Long Island. The verdict was returned, Apr. 5, by a New York Supreme Court jury. In sustaining the verdict, Justice Goff said in part:

> There can be no doubt that the crossing was more than usually dangerous. The highway slopes gently toward the tracks, descending more abruptly about 8 or 10 ft. before it reaches them. In the angle between the right of way and the highway and to the right of the party as they approached the tracks, there is a bluff made by a cut in the road, and another cut made for the railroad. The bluff is covered with trees and bushes, so that it was impossible for any of the party to look up the tracks to the right for more than four or five hundred feet until their horse was almost on the tracks.
>
> The danger of this crossing imposed a high degree of care on the railroad, which took three measures of precaution. It established a whistling post more than 1200 ft. away to the right; it erected sign posts near the crossing, with the usual warning words, and it maintained a flagman. There is evidence that the train whistled at the whistling post. But the evidence is that the flagman gave no warning to the party until it was too late.
>
> Had the railroad company exercised due care, it would have arranged some method of signalling the approach of the train which would have allowed the flagman more time. The absence of the flagman is an implied invitation for the driver to cross. The woman who was driving the carriage knew that a flagman was stationed at the crossing. She had a right to assume that if he was not waving his flag it was safe for her to cross.

The Steam Railways of Connecticut, according to the latest report of the Railroad Commissioners of Connecticut, are all controlled by the New York, New Haven & Hartford R.R., with the sole exception of the Grand Trunk's New London Northern line and a road 2½ miles long, owned by the Cheney Bros., of South Manchester.

Work on the Removal of the Pittsburg hump, a regrading scheme in the business section of Pittsburg, Penn., was begun on Apr. 5. The first earth was turned by Mayor Wm. A. Magee, with an ebony-handled silver pick and shovel. The contractor is Booth & Flinn, the second lowest bidder, but who took the work at the lower price bid by James H. McQuade on the representation that the latter to J. G. Armstrong, director of public works, that he was not in a position to execute the contract.

A Physical Valuation of the railroads of this country is authorized in a bill reported in the U. S. House of Representatives by the Interstate and Foreign Commerce Committee on Mar. 29. The measure enlarges the powers and duties of the present Interstate Commerce Commission, enabling it to make the valuation for fixing and adjusting rates. It is proposed to begin the investigation 60 days after approval of the measure, and to have the Commission report to Congress at the beginning of each regular session. Railroads displeased at the findings of the Commission will be given 30 days after filing of a report to enter a protest. Refusal to furnish information demanded is to be punished by a fine of $500 for each day the offense is continued.

The bill requires the Commission to report in detail on each piece of property owned by a railroad, and to show (1) the original cost for railroad purposes, (2) cost and value to the present owner, (3) increased value due to the cost of improvement, (4) property actually used in transportation and that for other purposes, (5) elements forming basis of estimated value, (6) history of the organization of operating corporations, (7) increases or decreases of capital stock in reorganization, (8) moneys received by reason of stock, bond, or security issue, (9) net and gross earnings and how spent, (10) amounts and dates of all bonds outstanding, (11) amounts paid for bonds, (12) names of stockholders and directors, (13) the connection of any bank or banker or association of capitalists, etc., and (14) the connection of such persons or institutions with the reorganization of a company in recent years.

The Fourth Conference on City Planning will be held at Boston, Mass., May 27-29, 1912. The following subjects will be considered: 1. The progress of city planning. 2. How to finance city planning. 3. Studies in the planning of specific areas. 4. The German principle of "zones," or differential building districts, as applied in the United States. 5. Some aspects of the transit problem.

At least one session will be devoted to a consideration of unclassified topics proposed by members and others interested. These topics may be presented in the form of short papers on any question relating to city planning. The secretary is Flavel Shurtleff, 19 Congress St., Boston, Mass.

Water Consumption and Waste at Buffalo, N. Y., averaged 163,485,025 gal. a day in March. This is 393 gal. per capita, based on the 1910 population of 423,715. Even if Buffalo increased in population as much from 1910 to 1912 as it did from 1900 to 1910 (71,328), the per capita consumption for March would still be more than 330 gal. a day.

A Bad Roads Census, taken by students in behalf of the Highway Committee of the Civic and Commerce Association of Minneapolis, led to the conclusion that during the year 1911 the business men of Minneapolis lost $910,000 by the diversion of country produce to St. Paul on account of bad roads. From the same data it was concluded that the farmers lost $608,000 by bad roads during the same period.

An Alleged Sewage Farm Nuisance was the subject of an unsuccessful suit for damages and a perpetual injunction (Comber v. the Municipal Council of Johannesburg), brought by a nursery gardener before the Rand Local Division of the Supreme Court of South Africa. The following account of the suit, with editorial comments, has been slightly condensed from the London "Surveyor" of Jan. 19, 1912:

This farm is under the joint control of G. S. Burt Andrews, city engineer, and Dr. Charles Porter, medical officer of health. The learned judge observed that the law of nuisance is not for the protection of the fastidious and dainty, but for the average plain and simple person; although, therefore, his lordship was quite prepared to hold that a smell existed in the neighborhood of the farm on occasions, and that it was sometimes disagreeable or offensive, the Court was not prepared to say that it was sufficiently pronounced or sufficiently continuous to amount to a nuisance.

In our humble opinion this is a common-sense view about a matter where opinion is often warped by sentiment. It had been suggested on behalf of the plaintiff that the defendant council had been negligent in not reducing the strength of the sewage by acquiring more land, or by adopting a different method of treatment. As to this the Court held that the problem before the town council was to deal with the sewage as they found it, and without being obliged to buy up the whole countryside or do things which cost a lot of money. If the council put themselves in the hands of competent advisers and honestly and conscientiously carried out their advice, the Court could not say that they had not taken reasonable care and that they had been guilty of any negligence.

The Panama Canal Dredge "Corozal," described in Engineering News of Jan. 25, arrived at Balboa, C. Z., on Mar. 27, after a voyage of 88 days from Falmouth, England, by way of the Strait of Magellan, a distance of about 12,000 miles. The "Corozal" will begin work at once in the Pacific entrance to the canal.

A Bill to Limit Weights and Speeds of motor trucks has been prepared by the Massachusetts Highway Commission and is now pending in the Massachusetts Legislature. The bill prohibits the running of any motor truck having a weight with its load exceeding 12 tons, except by obtaining a special permit. It is forbidden to attach to the wheels of a vehicle "any flange, ribs or other objects which will seriously injure, destroy or cut into the highway for any considerable depth." Besides the limitation above as to the maximum weight of loaded trucks, it is provided that no wheel shall have a greater load imposed upon it than 800 lb. per inch width of tire. These prohibitions apply to country roads and not to streets inside the limits of incorporated cities.

Speed limitations are also incorporated in the bill, applicable to motor trucks wherever run. The maximum speed for motor trucks weighing with load more than four and less than six tons is 15 miles per hour. Motor trucks with load weighing more than six tons must not be run faster than six miles per hour, if equipped with iron or steel tires, and not more than 12 miles an hour when equipped with rubber tires.

The bill also authorizes speed limitations to be fixed for traffic over bridges, provided a notice of the speed limitations is conspicuously posted at each end of the bridge.

Mill Dams in Ingersoll, Ont., are to be inspected by order of the town council to determine their safety. It is reported that Willis Chipman, of Toronto, has been engaged for the purpose.

Personals

Mr. J. H. Bryson, of Pembroke, Ont., has been appointed Town Engineer of Brockville, Ont., at an initial salary of $1800 per annum.

Mr. H. C. Williams, formerly Assistant Engineer of Construction of the Louisville & Nashville R.R. has been promoted to be Assistant Chief Engineer of Construction.

Mr. P. E. Crowley, Assistant General Manager of the New York Central & Hudson River R.R. at Albany, N. Y., has been appointed General Manager, with headquarters in New York City.

Mr. John Calder, M. Am. Soc. M. E., will resign his position as Manager of the Remington Typewriter Works, Ilion, N. Y., to become associated with the Cadillac Motor Car Co., Detroit, Mich., on May 15.

Mr. D. E. Thomson, of Toronto, Ont., has been elected President of the Mexican Northern Power Co., of Santa Rosalia, Chihuahua, Mexico, succeeding Mr. G. F. Greenwood, who becomes General Manager.

Mr. W. E. Smith, formerly Assistant Superintendent of the Louisville & Nashville R.R. at Birmingham, Ala., has been made General Superintendent of Construction, with headquarters at Louisville, Ky.

Mr. J. Frederick Jackson has severed his connection with A. William Sperry, Inc., of New Haven, Conn., and has opened an office at 831 Chapel St., New Haven, for the general practice of civil engineering.

Mr. Frank S. Avery, formerly of the firm of Verga & Avery, Contractors, of Camden, N. J., has withdrawn from his association with Mr. Verga and has opened an office at 9 Day St., Camden, as a general contractor.

Mr. Foster Crowell, M. Am. Soc. C. E., a consulting and civil engineer, and former Street Commissioner of New York City, has been appointed Consulting Engineer of the Borough of Queens, New York City, at a salary of $6000 per annum.

Mr. W. P. J. Dinsmore, for a number of years Manager of the Sullivan Machinery Co., at Denver, Colo., has been appointed Manager of the Chicago, Ill., sales office. Mr. G. W. Blackinton, of the Chicago offices, succeeds Mr. Dinsmore at Denver.

Mr. Carl J. Mellin, M. Am. Soc. M. E., Consulting Engineer of the American Locomotive Co., of Schenectady, N. Y., has been granted an indefinite leave of absence, and left New York City on Apr. 4 for an indefinite visit in Europe in search of health.

Mr. J. H. Peyton, M. Am. Soc. C. E., Assistant to the President of the Louisville & Nashville R.R., has been appointed Chief Engineer of Construction, succeeding Mr. J. E. Willoughby, M. Am. Soc. C. E., whose resignation was noted in our issue of last week.

Mr. Xerxes H. Cornell, formerly Inspector of Transportation of the Chicago & Alton R.R. and the Toledo, St. Louis & Western R.R., has been promoted to the newly created position of General Superintendent of Transportation, with headquarters at Chicago, Ill.

Mr. A. H. Smith, Vice-President and General Manager of the New York Central Lines at New York City, has had his jurisdiction extended over the lines west of Buffalo to include the duties hitherto performed by Mr. C. E. Schaff, whose resignation was noted in our issue of last week.

Mr. W. L. Robinson, formerly Special Inspector in the mechanical department of the Baltimore & Ohio R.R., has been promoted to be Road Foreman of Engines of the Baltimore division at Baltimore, Md. Mr. Robinson is a graduate of Purdue University, and began his railway work as a shop apprentice.

Mr. S. R. Alexander has resigned his position as Engineer of Bridges of the city of Baltimore, Md., to become Assistant Harbor Engineer. Mr. James W. Ogier, who has been in the city engineering department for a number of years, has been appointed Engineer of Bridges, succeeding Mr. Alexander.

Mr. John F. Hammond, M. Am. Soc. C. E., for the past six years President and a director of the firm of Hammond & Sloane, Inc., New York City, has resigned and, having purchased the firm's waterworks, sewer and pavement plant, will continue the business with offices at 123 Oak St., Richmond Hill, New York City.

Mr. W. W. Marr, M. Am. Soc. C. E., has resigned his position as Division Engineer in the Board of Local Improvements, at Chicago, to associate himself with the Aetna Engineering Bureau, with offices at 17 N. La Salle St., Chicago. Mr. Marr had been in the engineering service of the city of Chicago for 15 years.

Mr. W. Morris Chubb, formerly Examiner of Surveys in the General Land Office and a graduate of Ohio State University, class of 1907, has the distinction of being the first civilian to be commissioned in the Corps of Engineers, U. S. A. Mr. Chubb is a son of Col. Chas. St. J. Chubb, U. S. A., and was the only successful one of four aspirants for appointment.

Mr. Irving W. Reynolds, M. Am. Soc. M. E., whose announcement that he would retire from the office of Vice-President and Manager of the William Tod Co., of Youngstown, Ohio, was noted in our issue of Mar. 7, has returned to the engineering department of the Allis-Chalmers Co., of Milwaukee, Wis., of which he was for many years Chief Engineer.

Mr. H. C. Phillips, Assoc. M. Am. Soc. C. E., Chief Engineer of the Atchison, Topeka & Santa Fé Ry. Coast Lines, at Los Angeles, Calif., has been appointed Valuation Engineer of the Santa Fé System, with offices in Chicago, Ill. He is succeeded at Los Angeles by Mr. G. W. Harris, Assoc. M. Am. Soc. C. E., Chief Engineer of Construction of the Pecos & Northern Texas Ry., at Amarillo, Tex.

Mr. Lee de Forest, M. Am. Inst. E. E., Wireless Engineer of the Federal Telegraph Co., San Francisco, Calif., and inventor of the de Forest wireless telephone, has been indicted by the Federal Grand Jury of the Southern District of New York for misuse of the United States mails in connection with the sale of stock of the Radio Telephone Co., of New Jersey, of which he was a director and Vice-President.

Mr. Dana Pierce, Assoc. Am. Inst. E. E., Electrical Engineer of the Underwriters' Laboratories, Inc., of Chicago, Ill., will

take charge, on May 1, of the New York offices of the Underwriters' Laboratories, which have been consolidated at 135 William St., New York City, as Electrical Engineer and Agent. A station for testing electrical appliances will be operated in connection with the New York offices and will be used chiefly in the service of inspections at factories and labeling.

Messrs. W. W. Brown and C. D. S. Clarkson have formed a partnership under the firm name of Brown & Clarkson, Mining and Topographic Engineers, with offices in the Southern Bldg., Washington, D. C. Mr. Brown has spent eight years as Topographer in the United States Geological Survey and for nine years has been engaged in mining and railway location and construction in the United States, Mexico and Alaska. Mr. Clarkson was Topographer in the United States Geological Survey for 10 years, and spent one year as Hydrographic Surveyor for the Navy Department in Cuba. For the past two years he has been in private work for hydro-electric development and road construction.

Obituary

William Creighton, for the past nine years Assistant Superintendent of Roads of Allegheny County, Penn., died on Apr. 3, aged 75 years.

John M. Robinson, M. Am. Soc. M. E., President of the Crex Carpet Co., of New York City, died at his home in Hackensack, N. J., Mar. 30.

Webster Snyder, a pioneer western railway builder, died at his home in Dallas, Tex., on Mar. 26. He took part in the construction of the Union Pacific R.R., the Atchison, Topeka & Santa Fé Ry., and other early lines in the Southwest.

W. S. Downing, Superintendent for the Foundation Co., of New York City, at Dam No. 19, on the Ohio River, at Parkersburg, W. Va., was killed on Mar. 25, by the falling of an A-frame. He was born at Half Moon Bay, Calif., in 1873. Mr. Downing's experience in foundation work covered many of the most difficult building foundations in New York City, the last of his work there being the foundations for the new Municipal Building, described in Engineering News of Jan. 6, 1910. During the past 10 years that he had been with the Foundation Co. he had been in charge of many important undertakings covering the greater part of the Eastern and Southern States from Canada to Mexico. He is survived by a widow and two children.

Amos Lawrence Hopkins, former Vice-President of the so called Gould system of railways, died at his home in Boston, Mass., Apr. 4. He was born, Apr. 10, 1844, at Williamstown, Mass., the son of the late Mark Hopkins, President of Williams College. He entered Williams College in 1863, but soon left to accept a commission in the Union Army. He was promoted for bravery in action and left the army with the rank of Major. Subsequently he graduated with his class from Williams College. He entered the railway service in 1867 and in a short time was made General Superintendent of the Housatonic R.R., in New England. In 1869 he went West and for three years was General Superintendent of the Kansas City, St. Joseph & Council Bluffs R.R. From 1874 to 1880 he was Vice-President of the Illinois Central R.R., and also of the Wabash R.R. From 1883 to 1889 he was Vice-President of the Missouri Pacific Ry., and other of the Gould lines. He retired from active work in 1898 after three years as President of the New York, Susquehanna & Western R.R.

George E. Davis, Master Mechanic of the Elmira plant of the American Bridge Co., at Elmira, N. Y., and one of the pioneers in developing modern bridge shops, died on Mar. 26, at his home in Athens, Penn., from pneumonia. He was born in Philadelphia, Penn., in 1842, and studied civil and mechanical engineering. Later he removed to Easton, Penn., where he enlisted in Cooper's Battery B, First Pennsylvania Artillery, and served throughout the Civil War. At the close of the war, 1865, he went to Athens, with Charles Kellogg, M. Am. Soc. C. E., and was employed in building wooden bridges for the Lehigh Valley R.R. in that vicinity.

When Mr. Kellogg established a bridge shop at Athens in 1869, Mr. Davis was made its Superintendent, and he continued in that position under the successive managements of Kellogg & Maurice, the Union Bridge Co., and the Athens plant of the American Bridge Co. Later he was Manager of the plant until it was closed; after which and until the time of his death he was Master Mechanic of the Elmira plant, where his services were invaluable, and although the company officials had several times told him, that on account of his declining health it was no longer necessary for him to do active work, as they needed him most for consultation and advice, he continued to carry the full burden of his position till the time of his final illness.

Mr. Davis' service as Superintendent of the bridge shops at Athens began when the industry was relatively new, and there some of the tools and many of the shop methods now in general use were developed and introduced by him. His ability to devise methods of doing good shop work with simple and sometimes inadequate tools was marked, and he always had some ingenious method ready when a difficult shop problem was to be solved.

Mr. Davis had long taken a deep interest in the commercial and social affairs of the community. He was prominent in the Masonic Fraternity and had attained the rare distinction of election to the thirty-third degree. (Prepared by O. E. Hovey, Asst. Chief Engineer, American Bridge Co.)

Engineering Societies

COMING MEETINGS

AMERICAN ELECTROCHEMICAL SOCIETY.
April 18-20. Annual meeting at Boston, Mass. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

AIR BRAKE ASSOCIATION.
May 7-10. Annual convention at Richmond, Va. Secy., F. M. Nellis, 53 State St., Boston, Mass.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 14-16. Annual meeting at Chicago. Secy., F. H. Wentworth, 87 Milk St., Boston, Mass.

MASTER BOILER MAKERS ASSOCIATION.
May 14-17. Annual convention at Pittsburg, Penn. Secy., H. D. Vought, 95 Liberty St., New York.

AMERICAN RAILWAY ASSOCIATION.
May 15. Semi-annual meeting at New York City. Secy., W. F. Allen, 75 Church St., New York.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
May 16-18. Annual meeting at Pittsburg, Penn. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 22-25. Annual convention at Chicago, Ill. Secy., D. B. Sebastian, La Salle St. station, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 28-31. Spring meeting at Cleveland, Ohio. Secy., C. W. Rice, 29 West 39th St., New York.

AMERICAN WATER WORKS ASSOCIATION.
June 3-8. Annual convention at Louisville, Ky. Secy., J. M. Diven, 271 River St., Troy, N. Y.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 4. Annual convention at New York City. Secy., P. W. Drew, Soo Line, Chicago, Ill.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 10-14. Annual meeting at Seattle, Wash. Secy., T. C. Martin, 29 West 39th St., New York.

New England Water Works Association—The next annual convention will be held at Washington, D. C., Sept. 18 to 20, 1912.

Society of Naval Architects and Marine Engineers—The annual meeting will be held at New York City, Nov. 21-22, 1912, concluding with a banquet at the Waldorf-Astoria Hotel, on the evening of the 22nd.

Brooklyn Engineers Club—A sort of employment bureau has been established by the recent appointment of a committee "for the purpose of bringing together those parties wishing engineering assistants and those looking for positions." Anyone looking for an assistant is requested to specify what experience he must have had, and those looking for positions are requested to state their experience and the salary expected. No charge will be made for this service. The committee appointed is as follows: W. T. Donnelly, George A. Orrok, W. H. Roberts, J. C. Meem and Joseph Strachan, 117 Remsen St., Brooklyn, N. Y.

At the meeting of Apr. 11, Mr. Richard Schermerhorn, Jr., will present a paper on "City Planning," in which he will discuss general developments in American and European cities and the improvement plans for a number of cities in the United States.

American Institute of Electrical Engineers—The papers to be presented at the coming convention at Portland, Ore., Apr. 16 to 20, are as follows: "Operation of Two Alternating Current Stations Through Parallel Circuits and the Distribution of the Load and Wattless Current Between Them," J. W. Welsh; "Air Gap Flux Distribution in Direct-Current Machines," Charles R. Moore; "Principles to be Considered in Selecting a Water Wheel Unit," O. B. Coldwell; "Irrigation in the Spokane Valley," L. J. Corbett; "An Underground System and a Few Developments," S. B. Clark; "Alternating Current Systems of Underground Distribution," S. J. Lisberger and C. J. Wilson; "Automatic Private Branch Exchange Development in San Francisco," Gerald Deakin; "Long Distance Telephone Transmission on the Pacific Coast," C. A. Turner; "The Design of Telephone Pole Lines for Conditions West of the Rocky Mountains," A. H. Griswold; "The Application of Automatic Electric Devices to Telephone Multiple Switchboards," A. H. Dyson; "Plant Efficiency," J. D. Ross; "Practical Joint Pole Construction," J. E. Macdonald.